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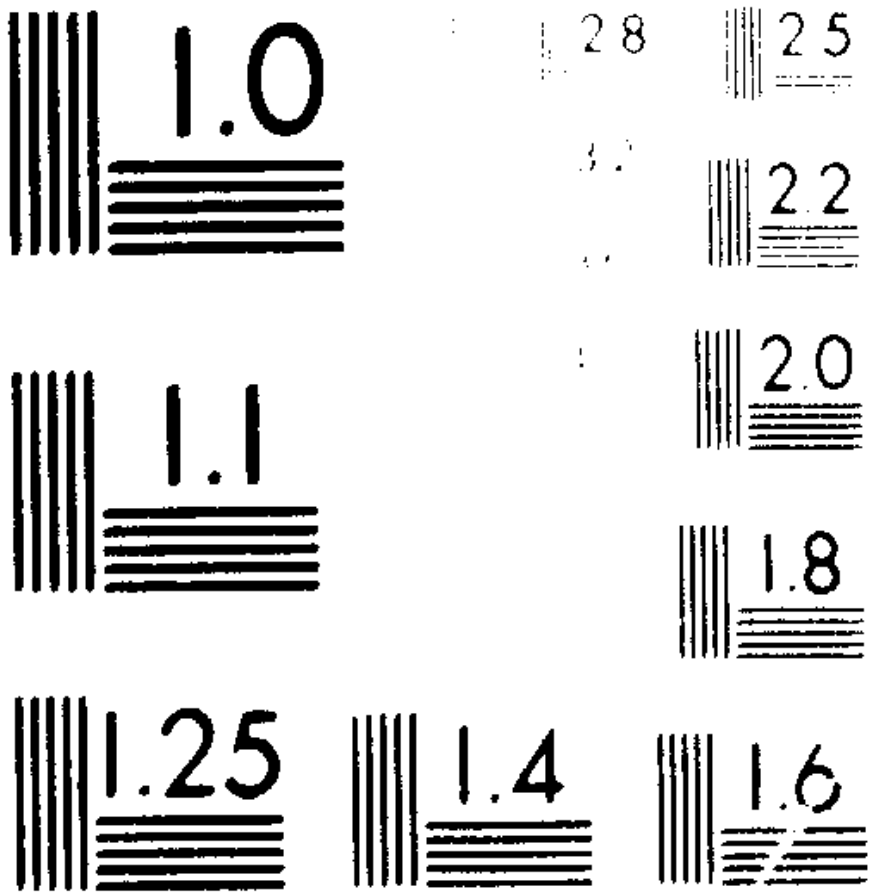
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INDUSTRIAL TESTING, RESEARCH AND DEVELOPMENT CENTRE

DP/SYR/77/004

SYRIAN ARAB REPUBLIC

Technical report: Assistance in Pilot Plant Processing*, Syria.

Prepared for the Government of the Syrian Arab Republic
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of M. V. PERLAN, Chemical Engineer

United Nations Industrial Development Organization

Vienna

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Thanks to the management officers of ITRDC and the counterpart Mr.Faruk Kadri for their collaboration during this mission.

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## 1. INTRODUCTION

This report refers to the results of activities performed in the period between 25.11.1978 and 25.11.1980 relating to the posts

DP/SYR/77/004/11-02/31.2.A

and

SP/SYR/77/004/A/01/37/11-05.

The work has been performed in the Industrial Testing, Research and Development Centre (I.T.R.D.C.), Damascus, Syria.

According to the statements of the Tripartite Review of Project DP/SYR/77-004 from 09.-14.09.1979 the expert's activity was involved in the following objectives:

- to assist the Centre in establishing appropriate Unit Operations (Pilot Plant) facilities (see: Review document, Infrastructural Development, point 2.2.),
- to initiate and/or strengthen the capabilities of the Centre in trouble-shooting on plant to plant and industrywise basis covering various industries (see: Review, Industrial Services Development, point 3.6., resp. Outputs, points 4b, 9 and 10).

Owing to the various reports and studies elaborated by the expert in this period of time and with the aim to present this final report of activities in a concentrated and explicit form, the textual part refers to the corresponding chapters or pages of the documentation listed in TABLE 1.

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## 2. IMPLEMENTATION OF P.D. IN ITRDC, DAMASCUS

### 2.1. Existing situation in P.D. at the start of work

The Pilot Department of ITRDC was intended and erected time ago as an individual technological unit which had to collaborate with other departments of ITRDC utilizing their specific performances, e.g. analytical & testing laboratories, documentation centre, division for economic evaluations, workshops for maintenance and the general managerial divisions as well.

At the expert's start of work still existing P.D. represented some fundamental features of a general type of pilot unit.

The building corresponded to basic requirements, but the various installations and services were yet to be provided. The installation of a bridge crane in the main hall should be - and it was later - performed before mounting the equipment items.

The installations have been realized only in part, wherefore lines for pressurized air, vacuum, inert gas, forced ventilation and heat supply with ducts for effluents should be constructed at time which can be done only after the equipment to be purchased have been known on a definitive basis of concrete deliveries.

The pilot equipment was selected for some operations only, with emphasize on the items for size reduction in solid state. The operational equipment included 10 (ten) elements with 1 (one) additional element for steam supply. Only the items for size reduction - 4 elements - have been mounted and they run for trial purposes in a short period of time.

Organizational questions relating to fulfilment of personnel, the storage of spare parts, contacting potential partners etc. had not been treated at all because of the initial stage of P.D. and owing to the intention to solve these and other problems after completion with adequate purchase of equipment.

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In such a way P.D. represented a unit in its state of partial erection and with strictly limited possibilities of a systematic work.

To obtain real insight in the character of the existing equipment items, detailed control of all data has been performed and shown in the corresponding reports, including technical features, availability of spare parts and applicability as well.

(See documentation in TABLE 1 ; No. I. pages 1,2,3,4,5
No.II. pages 1-10
No.III. pages 1-4;
No.IV. pages 1-4).

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2.2. Conceptualization of the further development of P.D.

Because of the provisional character of the existing P.D. it was necessary to elaborate a strictly defined conception for its development based on fundamental features concerning

- the professional character,
- the equipment,
- the staff of personnel,
- the management & organization.

Therefore the conceptualization of P.D. shall be treated in a complex way involving the existing facilities as an integral part of the whole unit.

2.2.1. Professional character of P.D.

In the area of chemical & process technologies it is intended that P.D. has a wide area of activities involved in various professional spheres.

It has to be emphasized that a pilot unit shall be a link
between theory and practice,
between research and operative, applicable and operative industrial work,
between scientists, teachers and practical routine professionists.

Therefore, a well defined and conceptualized pilot unit has to cover a large assortment of tasks which shall correspond to the level of the above mentioned factors in a defined country.

The main spheres of work which define the professional character of the P.D. foreseen are:

- Applied research including trouble shooting, rationalizations and technological improvements with mutual tasks emphasizing the applicability of results for industrial purposes,

- Training of both the industrial professional staff and the educational staff as well, emphasizing the need of adequately trained collaborators who obtain or refresh their professional knowledge and experience on concrete practical work based on theoretical suppositions.
- Consulting potential and existing consumers or owners of know-how about complex technological questions in operating lines and various stages up to the preinvestment phase.

In such a way P.D. should be able to be involved in resolving technological and adjacent problems which are encountered in

- industrial plants from their preinvestment steps up to the regular production etc.,
- educational organizations, professional schools and universities,
- engineering, techno-economical and trade organizations,
- planning institutions,

to obtain adequate technical, economical and financial solutions.

Obviously, such a conception of activities needs a corresponding approach to complex factors involved and mentioned as follows.

(See documentation in TABLE 1 ; No. III, pages 12-14, 15
No. IV, pages 8 - 10
No. XXX

2.2.2. Equipment

The equipment items involved in a pilot unit for chemical technology have to be selected on the base of the fact that the fundamental "building stones" of technology are both the Unit Operations (UO) and Unit Processes (UP).
The engineering practice in the area of chemical and similar technology proves the suitableness of such standpoint due to results obtained in a way which allows to reach the quickest and best solutions. A well conceived pilot equipment shall accomplish first of all the specific requirements of UO and UP, but even more, particular constructional features shall be chosen in a way which enables the single item to be applied for similar operations or processes. This is needed particularly in a P.D. because of wide variations of activities in various projects considering a relatively small price surplus for a multipurpose item compared with a number of individual items.

The principle of versatility resp. of multipurpose character of equipment items is of basic importance for adequate technical and economical performences of a pilot unit.

Obviously, the selection of equipment has to be based on the area of activities supposed to be treated by P.D. It means that the tasks connected with actual and future partners from various areas mentioned in 2.2.1. have to be considered in a way to allow the most economical selection relating to constructional features and further exploitability of single equipment.

The capacity rate of pilot equipment has to be in a reasonable relation between a laboratory-bench scale and a minimum industrial level allowing to proceed in the sense of scaling-up resp. scaling-down according to performable conditions of technological similarity and reproductibility of data.

The multipurpose character mentioned above reflects also on the selection of constructional materials of all parts of equipment which are in contact with the various materials treated.

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Therefore, a relatively increased price has to be considered, which, however, is justified because of the wide applicability area required.

Considering that the pilot equipment can be applied as individual items or in combinations as technological lines of variable complex character, it is suitable to select equipment items in a more or less similar capacity rate and with similar connection values for utilities.

(See documentation in TABLE 1: No. I. page 6,
No. VI. pages 12, 13 etc.)

2.2.3. Personnel staff

Any operating equipment needs adequate involvement of the human factor because only in such combination - even in case of highly automatic items - performances can be obtained in a suitable way. The professional profile of the staff has to correspond to the characteristics of equipment items on which the team is supposed to work. It means that the professional characteristics of the personnel shall be selected - resp. obtained by training - in accordance with the available equipment items.

The previously mentioned selection of equipment items based on Unit Operations and Unit Processes requires analogous type of the staff which has to be more or less trained and experienced on the same basis.

A well operating pilot unit has to include a staff of personnel engaged indirectly and directly in work. Whereas the structure of the indirectly engaged staff depends mainly on the general type of organization, the directly involved team consists of members who perform either creative brain-work or routine-work closely linked together in their operations.

In general, the staff which is engaged directly includes:

- process technologists of various degrees of education enabled to work on various types of equipment,
- maintenance personnel with specialists in mechanics, electrics and instrumentation,
- auxiliary personnel of semi-skilled team members for assistance and manual works.

In such a way the team of directly engaged collaborators involves a variety of members who differ either in their level of education (from technicians up to Ph.D. graduated) or in their type of professions.

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Obviously, the selection of the type of specialization depends on the type of equipment foreseen, wherefore this subject is treated particularly in chapter 2.3.

(See documentation in TABLE 1.: No. III., pages 20-23
IV., page 3,
V., page 12.)

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2.2.4. Management and organization

A pilot unit needs a well defined and acting organization of work which depends on the complexity of tasks connected with the assortment of operating equipment.

Even a pilot unit making part of a complex organization - like in the case of ITRDC - needs its particular management due to specific type of work which has to be performed. In such a way the management of a pilot unit encounters organizational and dealing problems which belong to the technical, commercial, financial, juridical and administrative sphere.

So the management of a pilot unit becomes similar to the situation in production units (in smaller scale) with emphasis on the variety and complexity of professional problems which belong to a large area of various technologies.

The involvement of management is oriented in questions about

- internal (basic) organization, e.g. planning, personnel politics, internal collaboration between divisions, supplies, technical & financial analyses of performances done, professional training, collection and recovery of data, disciplinary measures etc.,
- operational management, e.g. qualification of both the equipment and the personnel for concrete tasks, coordination and expediting the work, evaluation of results, compiling the documentation performed, exchange of experience, providing for maintenance and operative supply of facilities,
- external organization, e.g. contacting partners, orderers and deliverers, stipulation of contracts, defense

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of the documentation performed, advertising.

As far as the managerial efficiency is concerned, it has to be emphasized that, besides the treatment of the above mentioned questions, reasonable effects will be achieved only if continuity of work is guaranteed and really performed. Discontinuity of work connected with costly reinstallations, restarts, rehiring of personnel etc. can be fought with in time planned and performed contacts with potential orderers of tasks resulting in adequate, valid contracts.

Positive results of contracting do not depend only from the ability of the management of the pilot unit but even more, the unit must inspire the potential partners with confidence based on performable facilities obtainable by both the adequate equipment and the qualified personnel staff as well.

(See documentation in TABLE 1.: No. I. , pages 6-10,
III. , pages 16-20,
IV. , page 9
XXIX. , page 4.)

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## 2.3. Implementation of the Pilot Department

As mentioned in chapter 2.1. the existing situation of P.D. can be considered as a preliminary one in a state of partial erection with limited possibilities for the performance of a systematic work.

The implementation of P.D. with the aim to be capable of efficient performance, needs resolving of many problems which are described shortly in the following chapters from 2.3.1. to 2.3.8.

### 2.3.1. Qualification of the existing facilities of P.D.

Owing to detailed studies of the existing state of P.D. it was possible to resolve the following basic problems, e.g.:

- construction and installation of the bridge crane in the main hall,
- revision of electrical installations for the drive of existing motors,
- construction of supplemental lines for effluents deriving from the main hall,
- construction and installation of 1 (one) auxiliary laboratory desk,
- construction of support frames for some of the existing equipment items,
- technical revision of the existing 11 (eleven) items and their spare parts.

The above mentioned results of work were achieved and actually implemented on the basis of the recommendations of the expert.

Other additional tasks, e.g.:

- final fitting of equipment items except the elements for size reduction (still mounted),
- fix connections with electric power & water supply,
- manufacture of auxiliary containers,
- exhaust facilities for some equipment

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have not been solved, although it is more reasonable to provide for them after the delivery of supplemental equipment will be decided. This is logical because the final fixed disposition of heavy elements according to their dimensions and needs of space for working and maintenance.

For

- storage facilities of spare parts for the existing equipment and the supplemental items

no solution was found in this period of time.

In the next future and particularly during the delivery period for supplemental equipment it is necessary to provide for

- hiring adequate personnel including training

(see 2.3.2., 2.3.6.) enabling both the existing and the stepwise delivered supplemental equipment for regular work.

As far as only the existing equipment is concerned, it represents a partly implemented unit with a restricted operational area in operations and processes which belong to

- size reduction in solid state,
- homogenizing (partly) in solid/liquid state,
- separation (partly) in solid/liquid state,
- evaporation (partly) in liquid state,
- simple reactions in liquid state.

The absence of connecting elements - e.g. pumps, vessels, funnels etc. - as well of items which represent a sequence of technological operations - e.g. mixers, screens, driers etc. -, and non available operational personnel at all, the existing state of P.D. is of transitional character with no real conditions of contacting & contracting the potential partners as it is mentioned in the last paragraph of chapter 2.2.4.

Obviously, the existing equipment items have been considered as very useful elements in combinations with the later proposed

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supplemental equipment (see 2.3.2.) in the sense to build up adequate technological units or lines.

In TABLE 2. the main technical characteristics of the existing equipment items are evident.

(See documentation in TABLE 1.: No. I., pages 3-6,
II., pages 1-11,
III., pages 2,3,4,24
IV., pages 1-5,
V., pages 5,7,8,
tables 1,2/1-2/5,
3/1-3/2,
6/1
XII. total
XIII. total
XIV. total).

2.3.2. Selection of supplemental equipment

The selection of types of supplemental equipment in P.D. is based on the principle that P.D. has to cover the various needs of

- applicative research for
  - trouble shooting and
  - improvement in existing process lines,
  - establishment of technological features in new lines during preinvestment phases, erection and putting into operation;
- training purposes for
  - teaching personnel in various degrees of educational institutions,
  - operative personnel in industry, etc.

The large spectrum of applicability of the equipment requires an adequate selection of equipment based on the following suppositions which have to be considered as complex. There are:

- adaptability fo Unit Operations and Unit Processes,
- technological similarity and reproductibility of data obtained in the sense of scaling-up and/or -down,
- highest versatility and multipurpose character,
- componibility of items,
- reasonable stepwise implementation.

The principle of technological similarity and reproductibility has to be observed because of the need to obtain data and results of practical value, wherefore the simulation of operational conditions in the sense of adequate scaling-up (from P.D. size up to industrial conditions) or scaling-down (in opposite sense) is one of the essential features of equipment needed.

The versatility and multipurpose character is needed and can be obtained with pilot equipment because of non predictable operational conditions in the phase of ordering the equipment. Moreover, individual type of equipment results as a very expensive solution if a pilot unit has to cover a large spectrum of activities.

The componibility of equipment items (i.e. ability to be combined with other elements in sets or lines) contributes to adequate simulation of conditions for both scaling-up and -down operations.

The stepwise implementation is needed for practical reason. Fitting and trial running of equipment need a reasonable period of time and even the operational personnel shall be well trained on the spot before assuming concrete tasks of work. Nevertheless, a stepwise implementation results in reduced partial amounts of financial means, the final global sum will be higher because of inflation rate etc.

The adaptability for Unit Operations & Unit Processes was explained before and it is a fundamental condition for the selection of pilot equipment.

Under such suppositions the selection of the supplemental equipment included 37 elements with the following characteristics:

- the total amount of equipment items attains 48 elements (11 of them are still existing in P.D.),
- the interchangeable, multipurpose character is shown by the following relations between the amounts of equipment items involved in operations or processes for a defined state of aggregation relating to the whole quantity of elements for treatment in

  solid/liquid state . . . . . 70,2 %
  liquid state . . . . . 46,8 %
  solid/liquid/gaseous state . . 29,7 %
  solid/gaseous state . . . . . 23,4 %
  gaseous state . . . . . 6,4 %.

The percentage shows also the multipurpose character of the equipment selected because of its applicability for various states of materials simultaneously.

The versatility of equipment is also shown in the ranking list in TABLE 3 which relates to the componibility of all equipment

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items - existing and supplemental - based on documentation V., Table 3.

In TABLE 4 the basic character and scope of use for all equipment items are shown.

In the documentation, II., pages 25-63, fundamental data for the further elaboration of tenders are shown in the following paragraphs for each item separately:

- basic application,
- practical applicability as individual unit, as combined unit,
- specification,
- included parts and accessories,
- type of energy supply,
- constructional materials.

(See documentation No.: I., page 6
II., pages 12-63
III., pages 5-11, 24
IV., pages 4-8
V., pages 5-8
Tables 1,2,3,4).

2.3.3. Evaluation of investment costs for stepwise implementation of P.D.

The specific character of pilot equipment, e.g. capacity rate, constructional features, versatility of operations etc., renders difficult to apply usual methods for the evaluation of its investment costs based mainly on comparison, on unit price per weight or volume relating to the type of constructional materials, on application of the degressive exponential formula etc. To obtain as much as real data, the first action for this evaluation was oriented towards the notification of both the assortment and the characteristics of pilot equipment manufactured by various producers. After scrutinizing their production programmes, about 80 manufacturers of pilot equipment in Europe and USA have been contacted for sending their preliminary, not obligatory offers for items which ~~were~~ have been specified according to requirements expectd for P.D. These contacts started in February 1979 and the last bids arrived at the end of July 1979. The reaction of deliverers who have been contacted with a total amount of 116 tenders was positive. 88% of firms submitted their bids for 75 various types of representative equipment items requested.

The following period up to the beginning of 1980 was partly dedicated also to the compilation and scrutiny of informations obtained by the bids (see documentation VI, pages 1-227).

In such a way it was possible to

- elaborate well defined specifications for all types of equipment items foreseen (see chapter 2.3.4.),
- define approximative expenditures for planning purposes relating the purchase of equipment.

Based on the above mentioned preliminary bids and quotations it was possible to calculate the approximate level of basic expenditures.

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The subdivision into three steps of implementation was found reasonable as mentioned in chapter 2.3.2. and it was based on a suitable combination of equipment items permitting the performance of complex activities relating unit operations & processes and considering the stepwise rise of experience of the personnel involved.

Obviously, the initial informative amounts had to be considered as approximative because they have been based on preliminary, non obligatory quotations dated at the end of June 1979.

Because of administrative procedures from the issue of official tenders up to the effective ordering of equipment, a delay of delivery has to be calculated reflecting also on adequate increase of the price level (see documentation V, pages 18-21a).

Starting on day "X" with the official issue of tenders a period of about 13½-19 months has to be calculated up to the date of real operational ability of the equipment. This period of time includes: the optional period of bids, inflation rate, mounting period, time for clearing, handling activities, opening of accreditives etc. Considering the stepwise implementation in per year periods of 3 years, the final sum including deliveries of some auxiliary equipment for utilities, but without training expenses, amounts to:

US$ 392.040,- for step I. ,
US$ 561.440,- for step II. ,
US$ 300.080,- for step III.,

resp. US$ 1,253.560,- in total,

supposing the 3d step of implementation is accomplished at the end of 1983.
(See documentation V, tables 18/1,2,3).

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The construction and installation of the bridge crane was treated separately because of urgent character. The investment in the bridge crane amounts to

US$ 15.116,- .

(See documentation No.: II., pages 23-60
III., pages 9,10
IV., page 14
V., pages 18-49
VI., pages 1-227
IX., X., XI., XIII., XIV.).

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2.3.6. Elaboration of issue of tenders

The tenders documentation was prepared in February 1980 including technical and financial requirements in details for the 1st step and in shorter, informative extent for the next two steps of implementation. (see documentation V, pages 22-49 and XI, total 25 pages).

According to the decision taken between the local Authorities, UNDP and UNIDO the investment shall be covered by the competent Syrian institutions, wherefore the issue of tenders had to come up to local regulations.

The first tenders have been issued on 10.04.1980. Because of inadequate response, the second issue of tenders occured on 17.06.1980 in the Official Bulletin of Syria and on 18.06.1980, resp. 22.06. 1980 in newspapers Al Saura resp. Al Baas News.

A short description of the main technical characteristics of the equipment foreseen is shown in TABLE 5 , whereas the details are evident from the documentation V., pages 22-49.

(See documentation No. V, pages 22-49,
XI, 25 pages)

2.3.5. Results of bidding of equipment

According to the decision about financing the investment in P.D. - see chapter 2.3.4. - ITRDC formed a Committee for the acceptance of bids and their evaluation.
The expert was informed about the final selection of equipment, resp. he was asked in some cases to give advice relating to technical features of equipment presented in the various bids.

The closing date for bidding was fixed at 31.07.1980 and the Committee worked up to 31.08.1980 when its report was submitted to the financial division and the management of ITRDC for further treatment.

Due to inflation rates and relatively small repply to the tenders there was not worth mentioning competition between partners, wherefore the total sum for this step exceeded the previously calculated amount based on more competitive preliminary quotations submitted by several bidders.

The Committee selected the following elements shown in TABLE 6. It is evident that from the planned assortment of equipment, three items have been excluded because of exceeding the total sum available, wherefore step I. shall be subdivided into steps Ia and Ib. Step Ib can be treated in future as individual step or in connection with step II by adequate increase of its partial sum of investment costs.

Although a detailed system for bids analysis was elaborated by the expert before the issue of tenders (see documentation no. V., pages 50,51, Tables 19,20,20X), the small amount of bidders did not require its application.

The Committee's proposal concerning the selection of equipment items for step I. involves the sum of 388.331,7o Swiss Fr. for delivery CIF Damascus.
This value corresponds to

| | | |
|---|---|---|
| | Syr £ | 931.996,o8 |
| resp. | US$ | 216.743,- |

/23.

According to rough estimation of additional costs, mentioned in documentation V., pages 18-21a, supplemental costs in the amount of US$ 45.520,- can be expected for mounting and supplies of local character, for auxiliary equipment connected with items and for clearing and handling operations, wherefore a total expenditure amounts to US$ 262.260,- .

(See documentation no. V., pages 18-21a,
pages 50,51,
Tables 19,20,20X).

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2.3.6, Selection and training of personnel

Owing to the stepwise implementation of P.D. it is reasonable to provide also for a similar skilling of the personnel staff according to the enlarged assortment of equipment and the corresponding increased amount of tasks required.

In the actual situation P.D. involves only one person who was engaged as the expert's counterpart with parallel tasks in other domains.
In the documentation mentioned at the end of this chapter it is shown what amounts and particular professions should be involved in each step of implementation.
Summarizing these data it results that:

- in general 3 types of teams are foreseen with specialized professional knowledge and activities based on the main characterization of unit operations, e.g.
  - team "S" for operations with solids,
  - team "SL" " " " solid/liquid systems,
  - team "SLG" " " " solid/liquid/gas systems.
- the composition of the crew is shown in detail in TABLE 7 resulting in the following participation:

| | | |
|---|---|---|
| - technologists (degree PhD, MSc, BSc. C.E.) | 9 | 39,1% |
| - technicians (chem. technol.) | 5 | 21,7% |
| - technicians (mechanics) | 1 | 4,4% |
| - electricians (techn.) | 1 | 4,4% |
| - administrative personnel | 2 | 8,7% |
| - workmen | 5 | 21,7% |
| Total | 23 | 100,0% |

Such a diversification of professional work is connected with adequate engagement of equipment items which seldom interferes between single teams. It means that the responsability for certain type of equipment and the results obtained remains under the task of the same, specialized team, nevertheless various work can be accomplished on it.

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The above figures are intended for P.D. as integral part of ITRDC utilizing the performances of other divisions, e.g. the analytical & testing laboratories, documentation centre, maintenance and workshops and management as well.

(See documentation No.: III., page 23,
V., pages 11-17
Tables 8,9,10,11,12,13,14,15,16,17)

As far as the training of personnel for P.D. is concerned it is essential that it becomes performed on identical or same equipment b e f o r e the start of contractually determined operational tasks of P.D.

The training has to be performed in adequate testing and control workshops of suppliers of equipment. The training periods depend on the character of equipment but in any case the person involved must be aware of his responsability for further work on the equipment in P.D. wherefore he becomes trained.

During the period of mounting the equipment, the personnel must be actively engaged as well as during the trial run.

The above mentioned specialization of teams guarantees best results of work preventing unadequate or non professional approach to specific tasks and working conditions.
(see also documentation no. III., page 23, no. V. pages 14-17, Tables 14,15,16,17.).

The complex character of operational work for single team member needs adequate scheduling both the type and the duration of training.
From the total final amount of 23 persons, 11 of them (47%) have to be trained. The training for some persons occurs not only for one step of implementation. The participation in training is scheduled as follows:

in I. step for 4 persons,
in II. step for 8 persons,
in III. step for 11 persons.

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Detailed training schedule is shown in the documentation mentioned above. It concerns concrete engagement of single person in operations and types of equipment involved in his future work showing also for each step the period of time and the location (abroad vs. local) of training.

The local training is intended partly for team members who become trained in mutual work with members skilled before abroad, and partly as additional training for persons who still obtained experience abroad. In TABLE 3 summarized data are evident about the training schedules.

Obviously, it is the task of the management of ITRDC to select adequate team members according to their

- professional prequalification,

and

- readiness for work under specific diversified, variable and dynamic conditions in the P.D.

The training periods proposed in the final bidding for 1.step and submitted by bidders make part of the usual informative introduction into work wherefore the remaining periods - according to the above schedules - should be performed for more extensive skilling, taking into account the professional level of the single team member involved.

(See documentation No. III., page 23,
V., pages 11-17
Tables 8-17.)

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2.3.7. Further steps of implementing P.D.

What was expected as the project aim and was particularly expected on this task, has fully and satisfactory been achieved. For further follow up and implementing the P.D. on the field, the following actions have to be performed by the counterpart system on the basis of advice and instructions submitted by the expert's documentation mentioned and performed in this period of 2 years.

Two steps of activities are involved in the next implementation of P.D., e.g.:

1. immediate actions in P.D.,
2. complex actions concerning the management of ITRDC and the Syrian Authorities.

Ad 1.

The following activities have to be achieved which belong to the type of immediate actions realizable in P.D. directly:

1. Revision of installations & connections of the supplies of utilities according to requirements of both the existing and the supplemental equipment - precisely for step I. and approximately for steps II. and III.

2. Providing for separate and adequate storage facilities for spare parts with organization of a reasonable operative control of spare parts availability, resp. of needs of reordering them for all steps of implementation. In the actual state no control about spare parts exists at all and they are dispersed in various locations of ITRDC, wherefore it is very probable that some parts of them - concerning the existing equipment - became lost. Before putting these items into operation the situation about their spare parts must be cleared up, otherwise interruptions of work can be expected quite early.

3. Determination of microlocations for stationary (big) elements of equipment in various parts of the P.D. building and establishment of locations for outdoor mounted items.

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During the implementation of the I.step and owing to fundamental characteristics of equipment for the next steps,explained by the expert,it is possible to define the location of stationary elements which have to be indoor mounted,e.g.elements of code numbers: 108,109,110,01,03,08,10,14,19,20,21,25,29,30,32,35, 36 and 37,
and the outdoor mounted ones: 05,07,09,17,31,33.

4. Preparing and cleaning the rooms for fitting the existing items followed by the other ones after their delivery.

Ad 2.

In general,the following actions have to be performed in complex work between P.D.,the management of ITRDC and Syrian authorities:

1. Proceeding on the I.step of implementation with the ordering of delivery.Owing to the accomplished bids analyses for the I.step of delivery of equipment the logical continuation of work shall be performed in ordering its delivery.Considering the periods of time for official opening of acreditives, stipulation of contracts etc. it is expected that the delivery of equipment should be realized in the second half of 1981.

2. Preparatory works for the next steps of implementation. During the period of delivery of I.step it would be suitable to prepare tenders'documentation for the next steps (for I.b it is still made).The issue of relating tenders is connected with the availability of financial means for purchasing the equipment,resp. it has to be adequately subdivided like it was made for step I. because of insufficient amount of funds.

3. Hiring personnel staff for I.step of implementation and providing for training.It is indispensable to provide at time for the personnel involved in step I. and for its training as well. The staff shall be available after previously training -see chapter 2.3.6.- at least when the equipment is fitted on the spot,although it would be suitable to dispone with trained personnel even earlier because of the available existing equip-

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ment items for training. Till now this equipment is mounted only partly and it could be used only in restricted amount because no operational personnel was neither hired nor trained.

4. Contacting potential users of P.D.'s working performances. A pilot department shall be considered as an operating unit, like a small production plant, with specific technological tasks wherefore it can perform applicable results only in a systematical and well organized work. For economic reasons the work shall be performed as much as continuously. It is useless to dispose of a well equipped pilot unit for show or exhibition only. Therefore, not only a pilot unit has to be fitted out with adequate equipment and personnel, even more, it is necessary to provide in time for contractual arrangements, of short and long period, of work with partners. Because this question is of specific character, it is treated in the next chapter 2.3.8. separately.

(See documentation No.: I., pages 6-9
III., pages 12-24.)

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2.3.8. Further collaboration with potential partners of P.D.

The further activity of P.D. during and after installing the equipment in working conditions and after training of the personnel, concerns the contacts with potential partners with the final aim to stipulate contracts of short- or long- term character relating to operational work.

As mentioned before, such contracts are of real value if P.D. inspires confidence to the potential partners based on the suitable assortment of equipment enabled for work and on adequate personnel available for tasks requested.

In the starting period P.D. shall fight for its probation in an other way than later, when positive achievements of work become the best proof and reference for collaboration.

In any case the precontractual and final contacts between partners shall be performed on adequate professional level applying the same specific "language" which is based on detailed knowledge of technological and adjacent problems which become encountered and expected as well.
Therefore, the documentation VII, pages 1-132 shows basic technological features of 16 types of chemical technology which are existing or expected to be implemented in Syria. Adequate flow sheets and documentation show comparative indications for both the industrial and the pilot equipment with specified data about concrete operational tasks for each element of pilot equipment item involved. In such a way the competent personnel of P.D. resp. ITRDC possess a detailed operative manual resp. manuals, which shall be applied in the start of contacts with partners as well they shall be used as basis for the elaboration of similar ones relating to other technologies involved in Syria in the future. Owing to the fact that the data in these documentations are mainly based on practical experience obtained in adequate industrial branches, their value and applicability for scaling-up or - down is evident.

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The documentation mentioned presents the problems in technologies of:

- finalization of fertilizers,
- wet phosphoric acid,
- ammonium sulfate and ammonium phosphate,
- beneficiation of phosphate rock,
- hyperphosphate,
- sodium tripolyphosphate,
- paints and varnishes,
- some types of synthetic resins,
- urea-ammonium polyphosphate,
- synthetic cryolite via off gases from wet phosphoric acid,
- beet sugar,
- alkyl-aryl sulfonate and detergents,
- citric acid.

Obviously, other types of process technologies which belong to metallurgy, cement & building materials, ceramics, food products, pharmaceuticals etc. are of identical interest for P.D. because of the multipurpose character of the equipment selected. The collaboration with these industries as partners of P.D. shall be realized in cooperative activities between the competent divisions of ITRDC.

As mentioned before, the spectrum of potential partners belongs to various areas, e.g.:

- industrial plants,
- educational institutions of various levels,
- chemical engineering institutions,
- statal planning and similar institutions etc.,

because all of them are involved in various questions relating to the transfer of technology where pilot facilities are the best link between theory & practice.

(See documentation No.: I., pages 6-9,
III., pages 12-18,
VII., pages 132 and flow sheets).

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## 3. CONTACTS WITH CHEMICAL INDUSTRY & EDUCATIONAL INSTITUTIONS IN SYRIA

### 3.1. Direct contacts

Direct contacts visiting the following industries in Syria have been performed:

1. Paint & Varnish Plant, Damascus,
2. Glass Factory, Damascus,
3. Petroleum Refinery, Homs,
4. Dry Onion Plant, Salamyie,
5. Brewery Barada, Damascus,
6. Fertilizer Plant , Homs,
7. Chocolate & Candy Factory Garawi, Damascus,
8. Chocolate Factory Camelia, Damascus,
9. Pharmaceutical Plant, Damascus,
10. Technological Faculty of University, Homs.

The relating reports show the general situation in the plants. The main impressions which have been observed are more or less common in all the units, e.g.:

- difficulties about the supply of adequate raw materials and spare parts as well,
- absence of appropriate operative process control and product control (particularly in 7. and 8.)
- technological problems which remained unsolved during or after the trial, guarantee run of equipment (particularly in case 2. and 6.).

Advice and suggestions have been transmitted for improvements in cases where it was asked for (because in general, the plant's facilities have been pointed out by their personnel as "without troubles"), particularly in cases 2, 4, and 6. In the case 2. - Glass Factory - the needs of further assistance were transmitted to the Project Manager, the Director General of ITRDC and SIDFA as well.

(See documentation No.: XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII.)

/33.

3.2. Indirect contacts

During May 1979 the management of ITRDC asked for a compilation of data which should be applied for professional discussions in some types of industries, resp. as examples for further, similar elaboration to be performed later by the local staff.
In such a way questionnaires for the industry of

- ceramics,
- cement and
- glass

have been submitted to ITRDC.

(See documentation No.: XIX, XX, XXI.)

4. PARTICIPATION ON SEMINARS

The expert held lectures for professional audience two times, e.g. about

- "The role and importance of chemical engineering in developing countries ", May 1979

and

"Role of pilot facilities in the development of Syrian sugar industry" , June 1980.

Owing to actual topics treated in the two lectures, it was decided to translate them into Arabic. These intentions did not succeed in whole, except a partial translation of the second lecture as a summary performed by private iniciative of Mr. Abbara Soubbi from the Yeast Plant in Homs.

(See documentation No.: XXIX, XXX).

## 5. PARTICULAR STUDIES FOR ITRDC

During 1979 the management of ITRDC has been involved in some problems for which concrete solutions the expert was asked. These suggestions and propcsals related to various questions as follows:

- The conception about the approach to the problem of alternative raw materials for the production of synthesis gas for ammonia in Syria. This documentation was applied as working plan for the Committee working on this question. (documentation XV).
- For the seminar about phosphate industry held in Damascus in 1979 suggestions have been submitted about topics. (documentation XVI).
- Owing to the study about wool purification performed between ITRDC and Wool Centre, Homs, the expert submitted a detailed techno-economical study with corresponding drawings and operational features. (documentation XVII.).

For the expert dr. Thampy who was engaged in 1979 on problems of rubber & plastics technology, the expert prepared the translation from French into English relating a study about the application of rubber elements in rails constructions (documentation XVIII.).

(See documentation No.: XV, XVI, XVII, XVIII.)

## 6. CONCLUSIONS and RECOMMENDATIONS

As mentioned previously the Pilot Department (P.D.) of ITRDC was erected time ago in its basic features without real possibility of operational performances, wherefore its implementation according to the tasks of the expert's work needed various actions of very different character to be accomplished.

As result of particular activities done during this mission the CONCLUSIONS can be summarized as follows:

1. The CONCEPTUALIZATION of P.D. has been treated with special care and as a complex problem with the main aim to enable P.D. for operational activities according to the actual and future requirements of various types of Syrian processing industries and educational institutions as well.
   Therefore, it was foreseen to include several items of pilot equipment with interchangeable character and high versatility based on principles of Unit Operations and Unit Processes applied in chemical and similar technologies.

2. Due to the partly finalized building and installations ADDITIONAL WORK ON THE EXISTING FACILITIES has been ordered and partly performed with the aim to obtain basic conditions for work in a pilot department. In such a way the installation and construction of a bridge crane and additional ducts for effluents have been realized.

3. Owing to the concept concerning the pilot equipment, all steps for the expected purchase have been performed, e.g.: SELECTION OF TYPES OF EQUIPMENT, TECHNICAL SPECIFICATIONS, EVALUATION OF INVESTMENT COSTS FOR P.D. IMPLEMENTATION, CONTACTS WITH POTENTIAL DELIVERERS OF EQUIPMENT etc.

   The detailed actions in this sphere of work resulted in

4. the ELABORATION OF TENDERS for 37 various types of pilot equipment. This tender documentation was applied in the whole official issue of tenders performed by ITRDC.

5. The evaluation of INVESTMENT COSTS, based on both the preliminary quotations and the selection of equipment items as well, served as basic data for the competent Syrian Authorities engaged in financing of P.D.
On this basis the investment is planned in 3 steps according to a stepwise allocation of financial means and adequate stepwise involvement of the personnel.

   The total amount of investment capital attains the value of US$ 1,253.560,- (calculated at the end of September 1980).

6. The expert was involved as advisor in the EVALUATION OF BIDS obtained in the action of tendering the 1st step of implementation.

   The FINAL SELECTION about the purchase of the equipment for the 1st step was performed in collaboration with the adequate Committee of ITRDC and submitted to Syrian Authorities for final approval and further actions.

7. All DATA AND ARGUMENTATIONS required for the NEXT STEPS OF IMPLEMENTATION have been submitted in details to the counterpart.

8. The TIME SCHEDULE concerning the stepwise implementation of P.D. including the purchase of equipment and the particular needs for training have been elaborated in details.

9. As far as the question of the professional staff in P.D. is concerned, a detailed PLANNING OF HIRING AND TRAINING of directly engaged operational staff has been specified according to the professional profiles, the type and the duration of skilling as well.

10. Considering the actual unability of P.D. for operational work because neither adequate type of management nor efective contacts with future potential partners exist at all, DETAILED INSTRUCTIONS ABOUT MANAGEMENT IN P.D. AND FOR FURTHER CONTACTS WITH PARTNERS have been submitted for the two initial phases of the future work, e.g.
    - for the preparatory step up to the delivery of equipment

    and
    - for the operational step after delivery.

11. For further contacts of ITRDC, resp. P.D., with potential partners the expert submitted DETAILED ELABORATION OF 16 TYPES OF CHEMICAL & PROCESS TECHNOLOGY which are expected to be of interest for the Syrian industry, with the aim to facilitate the further contacts showing how to approach to potential partners. This report - see Table 1, item VII. - shows what type of pilot equipment corresponds to the industrial equipment items, in what extent and in what particular work P.D. should be engaged according to its activities in TROUBLE SHOOTING, TECHNOLOGICAL IMPROVEMENT, CONTROL and TRAINING of both the industrial and educational personnel.

In the above mentioned extent the tasks concerning the implementation of P.D. have been performed and resolved by the expert in whole.

The counterpart system disposes now of detailed documentation according to the expert's advice and verbal instructions for the future activities concerning either the implementation of P.D. or the proceeding of concrete work.

The documentation mentioned is listed in TABLE 1 of this report as an integral part of it. Due to the large amount of this material it is available in the record-office of UN in Damascus.

As far as the RECOMMENDATIONS are concerned they can be summarized as follows and in two spheres, i.e.:

- concerning specific questions which belong to this particular mission

and

- problems involved generally in the performance of advisory activities.

The first type of problems is shown in the various and specific elaborates submitted to ITRDC and which can be summarized as follows:

1. The P.D. making part of ITRDC, Damascus needs concrete managerial and professional guide which both of them have to be performed in the period of starting the works. The real first steps of implementation started after long discussions in the second half of 1980, although the basic data have been elaborated by the expert one year before. To avoid additional increase of costs and expenditures it is necessary to work continuously and to look at a reasonable speed of actions to enable the P.D. for real work as soon as possible. EXPEDITING OF ACTIONS for the implementation of P.D. is of highest importance particularly after the separation of the expert. Any stoppage of the planned activities will cause troubles involving subsequent delays reflecting on the development of ITRDC.

2. Owing to the fact that neither P.D. in its actual shape nor ITRDC with the extent of works performed for industry have attained some OBJECTIVE POSITIVE REPUTATION, the recommendation in this sphere can be summarized as follows:

2.1. The systematic PURCHASE OF SUPPLEMENTAL PILOT EQUIPMENT shown and argumented by detailed advice of the expert.

2.2. MOUNTING & INSTALLING the existing and the supplemental pilot equipment.

2.3. HIRING PERSONNEL for operational purposes according to the advices

2.4. TRAINING OF THE HIRED STAFF for the work on particular types of pilot equipment which has to be accomplished at time.

2.5. INTRODUCTION of staff and team members TO THE INDUSTRY for adequate contacts and for their enlargement of technological knowledge and experience.

2.6. REALIZATION OF CLOSE PROFESSIONAL CONTACTS WITH POTENTIAL PARTNERS not only for P.D. but even for other departments of ITRDC, e.g. analytical laboratories, testing division, division for economic evaluations, documentation centre etc.

2.7. A system of constantly performed SEMINARS & LECTURES in weekly periods shoud be introduced as indispensable task and criterion for all the graduated members of ITRDC with the aim to obtain
- increased activity in professional work,
- enlargement and refreshment of professional knowledge.

3. As far as the realization of the next two steps of P.D.'s implementation is concerned, the actions about the ALLOCATION OF FINANCIAL FUNDS WITH ALL PARALLEL ACTIONS of financial and administrative character have to be prepared IN TIME to avoid discontinuity of work. Otherwise the P.D. will result unable to solve tasks of complex character submitted by the industry after the real start of work.

4. The ISOLATION of P.D. from other departments of ITRDC has to be strictly avoided. Only as an integral part of ITRDC P.D.

will be able to approach and to solve the operative problems.The question of individual RESPONSABILITY has to be treated with particular attention and solved also with adequate remuneration.

The second type of problems of general character involves the following recommendations:

5. The COUNTERPART SYSTEM should be strenghtened and improved by

5.1. adequately prepared and effectively acting conditions BEFORE the arrival of experts on the duty station and in accordance with the tasks listed in job descriptions. (In the present mission a lot of time has been vasted for discussions,who should finance the implementation of P.D. and even if it is reasonable at all - these problems must be solved before job descriptionns and post adjustments).

5.2. Owing to the complex character of the various activities involved in the implementation of P.D.,verbal advice and informations have an operational feature for their immediate application,wherefore conditions must exist for the performance of written,typed,drawn or recorded documentation because all these types of documentation are the only ones remaining on the spot after the separation of the expert.
It means that adequate - real acting - facilities shall exist to avoid delays of expert's activities caused by his own typing,drawing and correspondence as well.

5.3. Effective transfer of suggestions,informations and advice in both directions (expert:counterpart and vice versa) can be achieved only by adequate and effective translations into the partner's language.During all the period of work the translatory system represented an unsolved and permanent problem causing delays and undesired misunderstandings.The interpreter shall be a professional

in technical language and able to act as simultaneous translator during official and operative meetings and lectures as well.

5.4. It results quite incredible that the system of reproduction and duplication concerning the regular operative documentation represented such an amount of troubles that some technical documentation remained available only in one original copy or it was reproduced outside of both the main organizations involved in the work (UNDP resp. ITRDC).

5.5. The members of the counterpart system for direct collaboration with the expert should be selected in adequate amount and on the basis of their professional profile and their real, active interest in work expecting their further activities to be performed after the separation from the expert. The direct counterpart should be engaged in full extent for intensive collaboration with the expert and without additional tasks of other character.

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# TABLES

TABLE 1. 1/1

| List of documentation refered in the final report | | | |
|---|---|---|---|
| Ref.No. | T i t l e | Issued on | Volume (pages) |
| I. | Initial report, for period of 03.12.78.-12.12.78. | 12.12.78. | 10 |
| II. | Report No.2, for period of 12.12.78.-20.01.79. | 20.01.79. | 64 |
| III. | Report No.3, for period of 29.11.78.-28.02.79. | 28.02.79. | 25 |
| IV. | Intermediate report, for period of 01.12.78.-01.08.79. | 09.08.79. | 19 |
| V. | Report about implementation of the Pilot Department | 10.03.80. | 128 |
| VI. | Report about results of preliminary bidding of equipment | 01.04.80. | 227 |
| VII. | Summary about the potential implementation of Pilot Department's facilities in various types of process technology applied in Syria (16 flow sheets included) | 10.09.80. | 132 |
| VIII. | Monthly reports about activities for local authorities, period from 02.79.-10.80. - total 21 reports | every month | 26 |
| IX. | Evaluation of expected costs for pilot equipment | 08.06.79. | 2 |
| X. | Priority list of pilot equipment, 1st phase of implementation | 19.06.79. | 5 |
| XI. | Tender documentation, 1st step of implementation | 03.12.79. | 25 |

Cont./2.

TABLE 1. (cont.1.)

| Ref.No. | T i t l e | Issued on | Volume (pages) |
|---|---|---|---|
| XII. | Operative informations about the installation of the existing pilot equipment (5 drawings) | 17.,18, 19.02.79. | 10 |
| XIII. | Tender for bridge crane in P.D. | 21.04.79. | 2 |
| XIV. | Data for bids analyses concerning bridge crane for P.D. | 04.07.79. | 8 |
| XV. | Initial list of data concerning raw materials for synthesis gas | 31.03.79. | 6 |
| XVI. | Proposals about topics for the seminar of phosphate industry | 08.04.79. | 3 |
| XVII. | Technical informations about the wool extraction (5 drawings) | 11.06.79. | 13 |
| XVIII. | Technical specifications concerning the delivery of grooved soles made of rubber for mounting below rails (Translation F/E) | - 05.79. | 12 |
| XIX. | Questionnaire about ceramic industry | 29.05.79. | 5 |
| XX. | Questionnaire about cement industry | 30.05.79. | 6 |
| XXI. | Questionnaire about glass industry | 31.05.79. | 6 |
| XXII. | Report about the visit of the Paint & Varnish Factory, Damascus | 01.06.80. | 2 |
| XXIII. | Report about the visit of the Glass Factory, Damascus | 30.06.80. | 3 |

Cont./3.

TABLE 1. (cont.2.)

| Ref.No. | T i t l e | Issued on | Volume (pages) |
|---|---|---|---|
| XXIV. | Report about the visit in the Brewery Barada, Damascus | 30.06.80. | 1 |
| XXV. | Report about the visit in the Fertilizer Comp., Homs | 07.07.80. | 4 |
| XXVI. | Report about the visit in the chocolate factory Garawi, Damascus | 05.07.80. | 2 |
| XXVII. | Report about the visit in the chocolate factory Camelia, Damascus | 07.07.80. | 2 |
| XXVIII. | Report about the visit of the Technological Faculty of University, Homs | 14.07.80. | 3 |
| XXIX. | Lecture "The role & importance of chemical engineering in developing countries" | 28.05.79. | 28 |
| XXX. | Lecture "Role of pilot plant facilities in the development of Syrian sugar industry" | 28.06.80. | 25 |
| XXXI. | Correspondence with 89 potential suppliers of pilot equipment for preliminary bidding | - | - |

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TABLE 2.

Basic feature of existing equipment

| Code No. | Denomination | Capacity rate |
|---|---|---|
| 101 | Jaw crusher | up to 200 kg/h |
| 102 | Hammer mill | up to 500 kg/h |
| 103 | Ball mill | up to 200 kg/h |
| 104 | Attrition mill | up to 50 kg/h |
| 105 | Agitator | 0,37 kW |
| 106 | Rotary filter | 0,1 m2 area |
| 107 | Filter press | 0,21 m2 area |
| 108 | Vacuum evaporator | up to 50 kg/h of evap.H20 |
| 109 | Spray drier | up to 7 kg/h of evap.H20 |
| 110 | Reactor vessel | vol.100 l , pressure 2 bar |
| 111 | Steam boiler | 30 kg/h,10 bar |

MF/mf

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TABLE 3

Ranking list relating to componibility of all pilot equipment items in P.D.

| Rank step | Equipment item Code No. | Denomination | Frequency of componible cases | Intensity in % relating to the total amount of equipment |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| I. | 24 | Feed & storage vessels | 45 | 93,7 |
| II. | 26<br>27<br>32 | Circulation pumps<br>Pressure vessels<br>Universal reactor I. | 29 | 60,4 |
| III. | 110<br>33 | Reactor vessel<br>Universal reactor II. | 27 | 56,2 |
| IV. | 105<br>01<br>02<br>34 | Agitator<br>Atomizer<br>Multideck screen<br>Dissolver | 26 | 54,1 |
| V. | 109<br>19<br>23<br>30 | Spray drier<br>Centrifuge<br>Metering pump<br>Absorption unit | 24 | 50,o |
| VI. | 103<br>16 | Ball mill<br>Rake leacher | 22 | 45,8 |
| VII. | 18 | Hydroclone battery | 21 | 43,7 |
| VIII. | 03<br>20 | Drum mixer<br>Liquid/liquid extractor | 20 | 41,6 |
| IX. | 14<br>17 | Extraction unit<br>Thickener | 19 | 39,5 |
| X. | 21<br>25<br>29 | Solvent rec.unit<br>Evaporator unit<br>Vacuum crystallizer | 18 | 37,5 |

TABLE 3 (cont.)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| XI. | 106<br>107<br>108<br>04<br>15 | Rotary filter<br>Filter press<br>Vacuum evaporator<br>Magnetic separator I.<br>Ultrasonic extractor | 17 | 35,4 |
| XII. | 08<br>11<br>31 | Chamber, vacuum drier<br>Electric arc furnace<br>Dust removal battery | 16 | 33,3 |
| XIII. | 22<br>28 | Flow tube mixer<br>Crystallizer vessels | 15 | 31,2 |
| XIV. | 111<br>05<br>07 | Steam boiler<br>Magnetic separator II.<br>Indir. rotary kiln | 14 | 29,1 |
| XV. | 09 | Dir. rotary kiln | 13 | 27,o |
| XVI. | 102<br>104<br>13 | Hammer mill<br>Attrition mill<br>Sand(Perl)mill | 12 | 25,o |
| XVII. | 101<br>06<br>12 | Jaw crusher<br>Pelletizer, pan drier<br>3-roller mill | 11 | 22,9 |
| XVIII. | 10 | Muffle kiln | 10 | 20,8 |
| XIX. | 37 | Injection moulder | 8 | 16,o |
| XX. | 35<br>36 | 2-roller calender<br>Extrusion press | 7 | 14,5 |

+) "5" =("4" x 100):48 ; 48 is the total quantity of equipment items.

TABLE 4

Applicability of pilot equipment items

| Code No.<br>Equipment item<br>State of materials<br>Unit operation | Application |
|---|---|
| 1 | 2 |
| 101<br>Jaw crusher<br>Solid<br>Size reduction | Size reduction with determined correlation of sizes relating to feed & output in accordance with types of materials treated. Particularly designed for primary, rough crushing. |
| Grain calibration | Performance of defined type of grain shape - cubic vs. flat grain with defined material flows and adjustment of reduction rate. |
| Scaling off | Splitting of particles in agglomerates or combined row materials with elimination of single mineral ingredients. |
| 102<br>Hammer mill<br>Solid<br>Size reduction | Like 101 but for assortments of finer sizes, for so called secondary crushing steps. |
| Grain calibration | Like 101 but for finer sizes. |
| Scalling off | Like 101 but for finer sizes. |
| 103<br>Ball mill<br>Solid<br>Size reduction | Variable conditions of size reductions according to retention time and the assortment of milling media involving also recycles. |
| Solid/gas<br>Dedusting of grains | Size reduction combined with forced air flow with removal of dust at variable flow intensity. |
| Solid/gas<br>Size reduction & drying | Size reduction with simultaneous flow of hot air at variable conditions performing parallel drying. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| Solid/liquid<br>Wet milling | Size reduction in suspension with recovery of fines and eventual reaction between the solid and liquid phase combined with adequate assortment of milling media and recycle rate of the suspension. |
| 104<br>Attrition mill | |
| Solid<br>Size reduction & screening | Size reduction of solids with variable insertion of screen elements of different mesh openings combined with recycling the output material. |
| Grain calibration | Size reduction of solids with adequate insertion of crushing rods of variable type for obtaining output with variable shape. |
| 105<br>Agitator | |
| Liquid<br>Mixing | Mixing & homogenizing multicomponent liquid systems with parallel physical & chemical performances, e.g. reactions, simultaneous precipitation and suspension, dissolving, gas emmission etc. |
| Solid/liquid<br>Mixing | Mixing & homogenizing multicomponent solid/liquid systems with physical and/or chemical performances e.g. suspending, emulsifying, precipitating, dissolving, heat transfer, gas emmission etc. |
| Liquid/gas<br>Absorption | Absorption of gases in liquids by application of suction impellers resulting in reactions, aeration, precipitation, heat transfer etc. |
| Solid/liquid/gas<br>Mixing | For combined operations & processes in heterogeneous systems combined with chemical reactions, e.g. catalytic processes at normal pressure, gas emmission, heat transfer etc. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| 106<br>Rotary filter<br>Solid/liquid<br>Filtration | Filtration at variable and controlled conditions regarding flow rates, intensity of washing the filter cake, elimination of occluded impurities, obtainable yields of filter cake and its quality. |
| 107<br>Filter press<br>Solid/liquid<br>Filtration | As mentioned for 106 but considering specific conditions of filtration resulting from the stationary variation of filtration, application of pressure and variable condition of filtrability. |
| 108<br>Vacuum evaporator<br>Liquid<br>Evaporation | Evaporation of water & solvents of lower boiling point at variable flow rates and vacuum intensity and temperature according to the type of solution treated. |
| Solid/liquid<br>Evaporation | As mentioned above but for treatment of suspensions or emulsions. |
| Solid/liquid/gas<br>Evaporation, degasing | Evaporation combined with elimination of absorbed gases in the feed or performed during thermal treatment at variable conditions of flows, vacuum and temperature. |
| 109<br>Spray drier<br>Liquid<br>Evaporation | Evaporation performed with direct contact of the heating medium and resulting in the performance of concentrate and dense liquid or granulated shape applying variable directions of material flows, their intensity, temperature, differential pressure resp. vacuum etc. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| Solid/liquid<br>Evaporation | Removal of dispersing media from suspensions and emulsions resulting in outputs containing low concentration of solvent or in granulated shape at variable conditions of temperature, flow rates, differential pressure etc. |
| 110<br>Reactor vessel<br>Liquid<br>Mixing & processes | Mixing or processing multicomponent systems of liquids with endo- or exothermal effects performed at variable conditions of temperature, material flows, retention time, intensity of mixing etc. |
| Solid/liquid<br>Mixing & processing | As mentioned above but for multicomponent systems of solid and liquid ingredients. |
| Solid/liquid/gas<br>Mixing, absorption & processing | As mentioned above but for multicomponent systems of all state of aggregation, e.g. aeration, catalytic processing etc. |
| 111<br>Steam boiler<br>Liquid<br>Heat transfer | Supplying heat energy as steam, for needs of other equipment items. |
| 01<br>Atomizer<br>Solid/gas<br>Size reduction | For micronization of solids with gas flow - air mainly - resulting in micronized material separated by the integrated dust separator at variable conditions of temperature, gas pressure, flow rate and recycling rates. |
| Solid/liquid/gas<br>Size reduction | As mentioned above but with introduction of supporting liquid. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| 02<br>Multideck screen | |
| Solid<br>Dry screening | Size separation of solids in a variety of screens according to international standards resulting in granulometric analysis of the input material. |
| Solid/liquid<br>Wet screening | As mentioned above but introducing simultaneously adequate flow of liquid performing parallel washing of grain surfaces according to physical or chemical effects obtained. |
| 03<br>Drum mixer | |
| Solid<br>Mixing | Homogenization of multicomponent systems of preground solids with simultaneously performed desaggregation of intermediate particles built-up in accordance with flows of materials, retention time, intensity of mixing, controlled evolvement of heat performed etc. |
| Solid/liquid<br>Mixing & processing | Treatment of multicomponent systems consisting of solids and liquids with performance of simultaneous chemical reactions at controlled flow rates, temperature, reaction dynamics etc. |
| Solid/liquid/gas<br>Mixing & processing | As mentioned above but including flows of inert gases according to the sensitivity of ingrediends treated and for safety purposes as well. |
| 04<br>Magnetic separator I. | |
| Solid<br>Dry magnetic separation | Separation of magnetic ingredients in systems of solids based on variable intensity of the magnetic field according to magnetic susceptibility of ingredients, grain size of ingredients etc. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| 05<br>Magnetic separator II.<br>Solid/liquid<br>Wet magnetic separation | Separation of magnetic suspensions from multicomponent liquid/solid systems based on variable intensity of magnetic field, temperature, flow velocity of the suspensions, according to magnetic susceptibility of ingredients to be removed. |
| 06<br>Pelletizer, Pan drier<br>Solid<br>Size enlargement & drying | Agglomeration of single or multicomponent solid systems combined by eventual drying in accordance with obtainable consistence of pellets, their shape and chemical composition. |
| Solid/liquid<br>Size enlargement & drying | As mentioned above but for multicomponent solid/liquid systems performable as result of chemical reactions or physical agglomeration, coating etc. |
| Solid/liquid/gas<br>Size enlargement & drying | As mentioned above but with direct introduction of combustion gases for drying with additional control of secondary effects of the drying media on the materials treated. |
| 07<br>Indirectly heated rotary kiln<br>Solid<br>Thermal treatment | Thermal treatment of single or multicomponent solid systems at defined conditions of temperature gradients, flow directions and rates, retention time, speed of kiln, controlling drying effects and secondary size reduction due to abrasion etc. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| Solid/gas<br>Drying & processing | As mentioned above but in combination of supplemental flow of inert or reactive gas, e.g. air for oxidation resp. reducing gases. |
| 08<br>Chamber, vacuum drier | |
| Solid<br>Drying | Thermal treatment of heat sensitive materials needing antioxidative protection or elimination of solvents performed at controlled temperature, vacuum rate, retention time etc. |
| Solid/liquid/gas<br>Drying, evaporation | As mentioned above but for treatment of very sensitive multicomponent solid/liquid systems with additional flow of inert gases. |
| 09<br>Directly heated rotary kiln | |
| Solid<br>Drying, calcining | Thermal treatment of solid systems with direct contact of combustion gases for heating according to variable flows of materials and heating medium (co- or counter-current), flow rates, thermal gradients, retention time, evolvement of dust particles due to abrasion and differential pressure, resulting quality of products and composition of off-gases etc. |
| Solid/gas<br>Drying, processing, size enlargement | Thermal treatment of solid systems as mentioned above but at variable character of combustion gases (oxidative, neutral or reductive) with eventual performed effects of agglomeration. |
| 10<br>Muffle kiln | |
| Solid<br>Drying, melting, sintering | Thermal treatment of solid systems based on heating by electric resistance resulting in melting or processing at variable temperature, retention time etc. |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| 11<br>Electric arc furnace<br>Solid<br>Melting & processing | Electrothermal & electrochemical treatment of multicomponent solid systems at high temperature including previously performed melting and following chemical reactions of components according to kW input, voltage, type of heat evolvement (submerged, open arc, resistance), temperature, reaction dynamics etc. |
| 12<br>Three-roller mill<br>Liquid<br>Mixing, homogenizing | Homogenization of multicomponent liquid systems of high viscosity in accordance with temperature, roll speed and pressure, material flows, variable characteristics of ingredients and products obtained. |
| Liquid/solid<br>Mixing & size reduction | Homogenization with simultaneously performed size reduction of the multicomponent solid/liquid systems (pretreatment of solids supposed) at controlled temperature, flow rates, roll speeds and gaps, recycling flows etc. relating to the final effects needed. |
| 13<br>Sand(Perl)mill<br>Solid/liquid<br>Mixing, size reduction & extraction | Treatment of multicomponent solid/liquid systems for homogenization, fine milling, suspending, emulsifying, solvent extraction applying recycling flows of grinding media of variable consistence and dimension, solvents, emulsifiers etc. at controlled speed, recycling rate, temperature, retention time etc. |
| 14<br>Extraction unit<br>Solid/liquid<br>Extraction (solvent) | Solvent extraction of solids based on intermittent or flushing solvent |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| | flow in variable rates, at variable temperature, retention time, type of solvent according to the raw material treated and the yields of extract needed including eventual simultaneously performed extraction of other ingredients. |
| 15<br>Ultrasonic extractor<br>Solid/liquid<br>Solvent extraction | Specific solvent extraction at so called gentle conditions for thermosensitive and volatile materials based on variable conditions of ultrasonic generation according to the type of systems, shape of vessels, temperature etc. |
| 16<br>Rake leacher<br>Solid/liquid<br>Leaching, extraction | Contercurrent treatment of solids with leaching reactants in liquid form based on mechanical and chemical actions combined with settling out coarse solid particles, their recyclation rate, temperature, flow rates, rake speed and amplitude of movement in accordance with leaching yields. |
| 17<br>Thickener<br>Solid/liquid<br>Precipitation, settling, leaching | Treatment of multicomponent solid/liquid systems, e.g. slurries, for separation of solids by sedimentation or for purification by leaching with adequate liquids according to the characteristics of the slurry, rake speed, retention time, flow rate etc. |
| 18<br>Hydroclone battery<br>Solid/liquid<br>Classification | Hydrodynamic classification of multicomponent solid/liquid systems at controlled feed rates, pressure difference, velocity of flow, tempera- |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| | ture, type of hydroclone element, nozzles and dimensions in accordance with the characteristics of suspensions treated and the sharpness of separation expected. |
| 19<br>Centrifuge | |
| Liquid<br>Centrifugation | Separation of multicomponent liquid systems of different densities based on continuous or discontinuous flows at well determined speed rates, temperature and retention time according to the degree of separation needed. |
| Liquid/solid<br>Centrifugation | Separation of multicomponent or simple solid/liquid systems with additional treatment of the separated solid phase by washing and recovery of mother liquors, based on various elements integrated in the construction, speed variations, retention time during various steps of centrifugation, permeability of materials etc. |
| 20<br>Liquid/liquid extraction unit | |
| Liquid<br>Extraction (L/L) | Extraction of liquids with solvents of variable density (higher or lower) performed at controlled temperature, flow rates of solvent, retention time, type of mixing the liquids in accordance with the characteristics of solvent and liquid treated. |
| 22<br>Flow tube mixer | |
| Liquid<br>Mixing, processing | Homogenization of multicomponent liquid systems including components of various viscosity and density and performance of chemical reactions during mixing at variable flow rates, differential pressure, temperature, retention time according to the efficiency of mixing and reacting. |
| Solid/liquid<br>Mixing, processing | As mentioned above but for solid/liquid systems (pastes). |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| 21<br>Solvent recovery unit<br>Liquid<br>Distillation | Recovery of solvents by distillation intended for rough separation performed at normal or reduced pressure at well defined flow rates, reflux rates, temperature gradients, resulting in a raw mixture to be treated for final purification in the element 25. |
| 23<br>Metering pump unit<br>Liquid,<br>liquid/solid<br>Proportioning | Exact feeding of liquids or suspensions of reactants at well defined variable feed rates, pressure, without contamination of lubricants, adapted for various types fo liquid or liquid/solid systems. |
| 24<br>Feed & storage vessels<br>Liquid- solid<br>Storage & handling | Storage of liquids or solids for further feeding, collecting after processing, applicable for various types of liquids including elements for discharge - valves, control pipes, covers, lifting handles, movable suppor construction. |
| 25<br>Evaporator unit<br>Liquid<br>Distillation, fractionation | Distillation and final fractionation of volatile liquids at normal or reduced pressure, with various types of columns or types of fluid movement - filled columns, bubble caps, perforated trays, thin film evaporation - working at variable flow rates, reflux rates, cooling efficiency, boiling temperature, vacuum etc, according to the sharpness of fractionation expected. |
| 26<br>Circulation pumps<br>Liquid & liquid/solid<br>Fluid dynamics | Transportation of liquid or liquid/solid systems at variable flow rates, |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| | conditions of pressure, temperature and characteristics of materials treated. |
| 27<br>Pressure vessels<br>Liquid<br>Fluid dynamics | As mentioned for 26 but designed for specific liquids or purposes where the transportation with apply of pressurized air or inert gas is reasonable. |
| 28<br>Crystallizer vessel<br>Liquid/solid<br>Simple crystallization | Stationary type of crystallization from adequately saturated or inoculated suspensions at normal temperature at conventional circulation of the liquid. |
| 29<br>Vacuum crystallizer unit<br>Liquid/solid<br>Forced crystalRization | Forced crystallization at well defined flow rate of the slurry, with intermittent inoculation of crystal seeds, prevention of redissolving of isolated crystalls due to evolvement of crystallization heat, according to the recycle rate and growth dynamics of crystalls, temperature in various phases of the flow, controlled cooling combined by evacuation etc. |
| 30<br>Absorption unit<br>Liquid/gas<br>Absorption | Treatment of multicomponent liquid/gas systems in closed circuit based on physical or/and chemical treatment with controlled flow rates, recycle rates, temperature, absorbing media etc. |
| 31<br>Dust removal battery<br>Solid/gas<br>Precipitation | Dust removal from multicomponent |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| | solid/gas systems according to the concentration and the size of solid fraction according to differential pressure, temperature, flow rates, dedusting efficiency by application of various types of filtering media etc. |
| 32<br>Universal reactor I.<br>Solid/liquid/gas<br>Chemical processing | Chemical reactions in multicomponent solid/liquid/gas systems performable at normal or light overpressure at controlled temperature, agitation, processing data of specific character, designed for variable types of materials treated and performed. |
| 33<br>Universal reactor II.<br>Solid/liquid/gas<br>Chemical processing | As mentioned above but for conditions of overpressure including adequate devices for pressure feeding, discharging, intermediate cooling, sampling etc. |
| 34<br>Dissolver<br>Solid/liquid/gas<br>Dissolving, shearing, homogenizing, processing | Physical and chemical treatment of various multicomponent systems particularly for processes where uniformity of components is needed and facilitation of process flows is obtained by adequate intensive mixing, shearing etc. Involvement of various types of impellers becomes adapted for specific requirements of reactants. |
| 35<br>Two roll calender<br>Solid, solid/liquid<br>Kneading, homogenizing | Pretreatment of raw materials and recycles in formulations which belong to the technology |

TABLE 4 (cont.)

| 1 | 2 |
|---|---|
| | of rubber and plastics at controlled pressure, temperature, speed and material flows according to types of materials involved. |
| 36<br>Extrusion press<br><br>Solid<br>Shaping, pelletizing | Pretreatment of raw materials, recycles and final treatment of products in the technology of plastics and synthetic resins at controlled conditions of flow rates, temperature, pressure, recycle rate, grain shape in accordance to the type of material treated. |
| 37<br>Injection moulding machine<br><br>Solid<br>Moulding | Finalizing technology of plastics performable at well defined flow rates, pressure, temperature, characteristics of moulds with relation to the quality of products expected. |

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TABLE 5

Basic characteristic of pilot equipment involved in 3 steps of implementation

| Equipment item | | Capacity range and main characteristics |
|---|---|---|
| Code No. | Denomination | |
| 1 | 2 | 3 |
| I.STEP | | |
| 01 | Atomizer | For solids, output 20-200 kg/h, product size mainly 2-3 microns |
| 02 | Vibro screen | For dry & wet screening of solids, rate 200-400 kg/h with sieves DIN 4188 from 8,0 to 0,025 mm openings. |
| 03 | Drum mixer | for solids and s./liquids, rate 500 kg/h by batchwise operations. |
| 04 | Magnetic separator I. | For solids, variable sensitivity, rate up to 100 kg/h of preground material. |
| 09 | Rotary kiln | For direct heating of solids, fuel gas up to 650°C, cylinder ø 300-400 mm x 1500-2200 mm, for co- and countercurrent flow. |
| 12 | Three roller mill | For solid/liquid systems, rolls ø 100-150 mm x 250-350 mm, with cooling. |
| 13 | Sand(Perl)mill | For attritive milling, suspending & extraction of solid/liquid systems, rate 50-200 kg/h. |
| 14 | Extraction unit | For solid/liquid and liquid/liquid extraction, including solvent recovery, rate 20-200 l/h of solvent circulation. |
| 18 | Hydroclone battery | For hydrodynamic separation, with sets of hydroclones, interchangeable, overflow pump, rate up to 4 cbm/hour with solids size 0,1-0,5 mm. |

cont.

TABLE 5 (cont.)

| 1 | 2 | 3 |
|---|---|---|
| 22 | Flow tube mixer | For in-line mounting, heating & cooling jacket included, variable, removable amount of baffles, pressure rate up to 40 bar. |
| 23 | Metering pumps | Assembly with motor drive, stepless adjustment of piston stroke length and frequency for drive, with pump heads of piston- and diaphragm pumps, rate up to 200 l/hour. |
| 25 | Evaporator battery | For solutions, rate 25-40 l/h of evaporated water, applicable for normal pressure and vacuum, optional type of evaporation. |
| 26 | Circulation pumps | For liquids or suspensions of various chemical character, rate up to 20 l/min, movable, with motor drive integrated. |
| 31 | Dust removal battery | For separation and collection of dust particles, filtering surface 5 m2, with counterpressure facilities for cleaning the filter elements. |
| 34 | Dissolver | Package unit with vessels, impellers for dispersing, shearing, suction etc. for solid/liquid/gas systems. |
| II.STEP | | |
| 05 | Magnetic separator II. | For separating magnetic suspensions, variable intensity of magnetic field, rate 500 kg/h of suspension containing solids of maximum size 1,0 mm. |
| 07 | Rotary kiln | Indirectly heated with heating medium, effective main body volume 100-200 l, operational temperature up to 300°C. Alternative construction as tumble drier. |
| 08 | Chamber vacuum drier | For vacuum treatment, feeding surface up to 5 m2, temperature up to 300°C, vacuum up to 100 mbar, stationary type, with vacuum assembly. |

TABLE 5 (cont.)

| 1 | 2 | 3 |
|---|---|---|
| 10 | Muffle kiln | For thermal treatment of solids in stationary state up to 1500°C, effective volume of the heating chamber about 20 l, control system is included. |
| 17 | Thickener | For settling and sedimentation of solid/liquid systems, with scraper, adjustable baffles, bottom pump and drive mechanism; effective volume up to 750 l; set of two elements for countercurrent leaching. |
| 19 | Centrifuge | For centrifugal separation of liquid/liquid or solid/liquid systems, with interchangeable types of baskets and bowls, rinsing installations, discharge device, closed construction, C-factor 2000-2500. |
| 20 | Liquid/liquid extractor | In variable construction features, e.g. as drum contactor, pulsation column, perforator etc., for treatment of liquids with difference in specific gravity 0,05-0,5 and for circulation rates of feed about 50 l/hour. |
| 21 | Solvent recovery unit | As additional part for code no.25 (see step I.) the specification depending on the selection of element no.25. |
| 23 | Metering pump unit | As additional elements for code no. 23 mentioned in step I. with double piston pump, rate up to 200 l/h, pressure 6 bar according to the drive unit mentioned in I.step. |
| 24 | Feed & storage vessels | As movable elements, volumes range between 50-400 l, with bottom and overflow fittings, reinforced rigid top edge, cover and frame included. |
| 25 | Evaporator unit | Additional elements of the unit no.25 in I.step for fractionation, as thin film evaporator, operational temperature up to 200°C, capacity boiling-up max.20 l/hour, interchangeable elements. |

TABLE 5 (cont.)

| 1 | 2 | 3 |
|---|---|---|
| 27 | Pressure vessels | For handling liquids or suspensions, tanks in blowcase construction, effective volume 50-100 l, fittings and valves for in- and outlet and connections to compressed air supply included. |
| 28 | Crystallizer vessels | For stationary crystallization with volumes up to 400 l, cover, bottom socket, double wall for heating & cooling included. |
| 32 | Universal reactor I. | For unit processes in mixed systems including covered vessel, capacity rate 50 l, operational temperature between -30°C and +250°C, pressure up to 3 bar, with heating & cooling coils for thermal oil resp. water, stirrer with variable speed control, accessories for refluxing, cooler, receiver tank, reflux proportioner etc. |
| 35 | Calender | For homogenization by kneading, particularly applicable for rubber- and plastics technology, capacity up to 50 kg/hour with complete set for feeding, heating, cooling, conveying and control. |
| 36 | Extrusion press | As integral part if code no. 35. |
| | III. STEP | |
| 15 | Ultrasonic extractor | For extraction of thermosensitive compounds, vessel volume about 100 l, with integrated U-sonic generator and fittings for variable positioning the U-sonic source. With double wall for water cooling and cover for connection with heat exchanger for solvent refluxing. |
| 16 | Rake leacher | For treatment of solid/liquid systems and extraction by mechanical movement and simultaneously included sedimentation, variable speed and frequency, effective bowl volume up to 400-500 l. |
| 23 | Metering pump unit | As additional pump heads to code no. 23 mentioned in I. and II. step with various constructional features in accordance with the main drive unit. |

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TABLE 5 (cont.)

| 1 | 2 | 3 |
|---|---|---|
| 24 | Feed & storage vessels | As additional elements to item no.24 in II. step with similar characteristics. |
| 26 | Circulation pumps | As additional elements to item no.26 in I.step with similar characteristics. |
| 29 | Vacuum crystallizer unit | For crystallization from liquids-solutions or suspensions with integrated elements for feeding, circulation, in flow cooling, condensation of solvent and crystallization as well, with forced circulation and vacuum control, rate expressed as crystalls recovery amount of 40% from a saturated solution of NaCl. |
| 33 | Universal reactor II. | For unit processes in mixed systems (solid/liquid/gas), operational pressure up to 300 bar, temperature up to 400°C, effective volume of autoclave body 5,0 l, electric heating, magnetic stirrer, cooling coil, circulatory compressor and all safety and control devices included. |
| 37 | Injection moulder | For treatment of plastics in pilot scale, with various Ø of cylinders, pressure up to 2000 bar, shot volume up to 150 ccm, electric heating, automatic lubrication, for mould heights 80-350 mm, opening stroke max. 300mm, all safety and control elements included. |

TABLE 6

List of equipment items selected by the Committee for I.step of implementation

| Code No. | Denomination |
|---|---|
| 01 | Atomizer |
| 02 | Multideck screen |
| 03 | Drum mixer |
| 04 | Magnetic separator I. |
| 12 | Three-roller mill |
| 13 | Sand (Perl) mill |
| 18 | Hydroclone battery |
| 22 | Flow tube mixer |
| 23 | Metering pump unit |
| 26 | Circulation pumps |
| 31 | Dust removal battery |
| 34 | Dissolver |
| Equipment items excluded,resp. foreseen for step Ib.or II. | |
| 09 | Direct heated rotary kiln |
| 14 | Extraction unit |
| 25 | Evaporator battery |

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TABLE 7

Requirement of personnel staff per step of implementation

| Personnel staff needed per step | | | | Total amount needed |
|---|---|---|---|---|
| Qualification | Step | | | |
| | I. | II. | III. | |
| Technologists (PhD, MSc, BSc. C.E.) | 3 | 2 | 4 | 9 |
| Technicians (Chem., technol.) | 2 | 2 | 1 | 5 |
| Technicians (Mech.) | 1 | - | - | 1 |
| Electricians | - | 1 | - | 1 |
| Typists | 1 | 1 | - | 2 |
| Semiskilled worker | 1 | 1 | 3 | 5 |
| T o t a l | 8 | 7 | 8 | 23 |

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TABLE 8

Summarized data about training schedule

| Training location/step | | Training characteristics | | |
|---|---|---|---|---|
| | | total amount of months | participants | average month/man |
| ABROAD/ | I. | 14 | 4 | 3,5 |
| | II. | 10 | 5 | 2,o |
| | III. | 20,5 | 8 | 2,5 |
| total | | 44,5 | 17 | 2,6 |
| LOCAL / | I. | - | - | - |
| | II. | 9 | 5 | 1,8 |
| | III. | 11 | 8 | 1,4 |
| total | | 20,o | 13 | 1,5 |