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DP/CPR/88/001

THE PEOPLE'S REPUBLIC OF CHINA

Technical report: Fermenters in the Wuxi Enzyme Factory *

Prepared for the Government of the People's Republic of China
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of J. Fari, consultant in fermentation technology

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Chemical Industries Branch

United Nations Industrial Development Organization
Vienna

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* The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO). This document has not been edited.

V.93-88962

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BACKGROUND

PROJECT NUMBER AND TITLE:	DP/CPR/88/001/11-58 Improvement of Technology for the Production and Development of Enzymes at Wuxi Enzyme Factory
OBJECTIVES OF MISSION:	- To evaluate the present technical level of fermenters in Wuxi Enzyme Factory - To examine the local facilities for the manufacture of fermenters - To give advice in preparing technical documentation for pilot size fermenters
DURATION OF MISSION:	21 days including travel time, briefing and debriefing, and preparation of report

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INTRODUCTION

This report has been written by Dr. János Fári as a result of the mission to Wuxi Enzyme Factory from 23 May to 12 June 1993. The initial objectives are listed in the job description in Annex 1. They have not been revised and the expert has, responding to additional requests, given some suggestions and professional advice. As regards the general situation in Wuxi Enzyme Factory, this can be referred to in the reports of Mr. P. Bouchez and Mr. I. Balogh, who were at the site at the same time.

The enzyme production in Wuzi Enzyme Factory is at present operating both in the old workshops as well as in a new complex. The latter, a separated unit at the same site, has been constructed and complies with the current international standards.

In the old workshops, 12 pieces of $20m^3$ and 3 pieces of $60m^3$ fermenters are installed. The $20m^3$ pieces are very old which must have been in operation since approximately 15-20 years. The construction material they use is mild steel with stainless steel plating. This is also true in the piping work; mild steel has been used for the piping and valves. The quality of these fermenters do not meet the current requirements of the pharmaceutical industry.

The sterile air-supply system and feeding facilities are also out of date and in a very bad condition. At present, they are hardly adequate to support a reliable fermentation system for the production of high quality enzyme. The high rate of contamination could, in most cases, be explained by these facts.

The $60m^3$ fermenters have been manufactured of Chinese made stainless steel (304). The piping material has been also Chinese made from the same stainless steel but a higher quality stainless steel membrane valves have been used. The air and feed supplies for these units are provided by the old system. It is the expert's advice that the air and feed supplies are inadequate, hence, they should be improved.

In the new building, 3 pieces of $80m^3$ fermenters have been installed. They have been designed, manufactured and installed to meet current standards. Not only the fermenters are modern, but the building itself is very attractive. The expert had, however, no opportunity to see the air-supply system and the feeding facilities in the new workshop.

It is clear that the increase of enzyme production in Wuxi Enzyme Factory is important and therefore a decision was made for the installation of the $60m^3$ fermenters and for the construction of the new building with the $80m^3$ fermenters. The new joint-venture named 'Wuxi Synder Bio-Products Co. Ltd' is a further step along this line.

It is in general a principle that in the fermentation process of an industrial size, the fermenters are only parts (though the most expensive ones) of the whole fermentation system. The other components such as sterile air supply, the feeding preparation and its transfer, the piping, valves, instrumentation and other accessories are also considered as integral parts of the system in a broad sense. The computer control with its hard and softwares has also become an important part of the system. Good fermenters alone without harmoniously coordinated facilities cannot guarantee satisfactory results.

In this respect, the present fermentation system in the old workshop is not adequate. It seems that the old $20m^3$ fermenters will be and should be replaced by ones of perhaps bigger sizes. Special attention should also be drawn to the steam sealing for rotary shafts of fermenters and to the steam locks at sensitive pipe connections; in general, to sterility.

The present feeding-system with its pipe connetions to different fermenters is a high potential source of contamination even with steam locks. In the mixing vessel and the joining pipe-system, particularly in dead spots of the piping and valves, there is a continuous possibility for the growth of contaminating micro-organisms. It is absolutely a necessity to have proper washing and sterilization until a new and modern system will be available. In general, the possiblity of back-contamination of steam, air, and water service lines must be regarded as severe hindering factor.

The Wuxi Enzyme Factory is a typical production-oriented unit. There is only one laboratory available for the maintenance of cultures required for production. Facilities are limited for the further development of strains in use or for any kind of research in this field. It is obvious that the management realized that without bench-top laboratory and pilot scale

fermenters, they cannot make process or product improvement. These small fermenters are by all means essential to any kind of development programme.

In spite of the fact that down-stream processing was not within the framework of the expert's assignment in Wuxi, he pointed out that, modern laboratory or pilot plant size equipment in this field are also required for the improvement of yield and quality of the enzyme production.

At the request of Mr. Huo Xin-yun, UNIDO expert reviewed the combination of the steam lock arrangement of the double mechanical sealing system and rotary shaft bearing house of the $80m^3$ fermenters in the new workshop which was installed recently. Through this activity, the expert had the opportunity to meet with the technical staff and had delivered a lecture on the topics concerned.

I. ENGINEERING AND MAINTENANCE FACILITIES IN WUZI ENZYME FACTORY

The activity of the workshops at the factory is limited for the repair and maintenance that are necessary. They do not manufacture tanks and similar equipments locally, that is why the machinery available is satisfactory only for the tasks of repair and maintenance. All the fermenters and piping work are made by other companies. The design and the quality of the new fermenters, as well as those of the piping and instrumentation indicate that such institutions and factories are available to carry out this type of work.

II. VISIT TO CHENGFENG FURNACE CO. LTD. IN JIANGYIAN CITY

During meetings held with managers to discuss about fermenters and the production of enzymes, it was made clear to the expert that the management is willing to manufacture small-size fermenters. We were of the opinion that this can be carried out by other companies. On the basis of this conclusion, Mr. Huo Xin-Yun organised a short visit to the Chengfeng Furnace Co. Ltd. located in the nearby Jiangyian City. Chengfeng Furnace Co. Ltd. not only manufactures furnaces, but also tanks and different equipment for the chemical industry on regular basis.

The facilities of this company are furnished with proper manufacturing equipment. They are working with local stainless steel 304 upto 12 mm and they use argon gas-welding. They have automatic welding facilities and hydraulic press for deep-dish bottom manufacturing. The V-welding are inspected by X-ray instrument on the spot. The welders prepare test-welding pieces before they start actual welding for production.

Mr. Fang Shi Hing, General Manager of the factory, is a highly qualified engineer with a broad knowledge in different fields of manufacturing equipment. Brochures (in Chinese) on the manufacture of equipment for the pharmaceutical and chemical industries are available from their offices. The official publications of norms for different reactors, tanks and vessels, are relatively comprehensive. A factory located in Shanghai, for example, is offering an impressively large variety of mechanical sealing devices for

rotary shafts. The technical standard of these latter publications is very good.

As a result of the visit, we can assume that this factory can manufacture vessels of smaller fermenters of up to $10m^3$. This assumption, however, should be reconfirmed. The electro-polishing of these small vessels has to be organised somewhere else. They would also be unable to execute the delicate piping work of the fermenters.

III. STEAM SEALS/LOCKS

At the beginning of the visit in Wuxi Enzyme Factory, the expert had the opportunity to see and examine the old workshops. The observations together with the discussions held later on different problems of running the production, had revealed one severe problem: microbial contamination. This is very common at the alfa-amylase fermentation, but not so critical at the gluco-amylase fermentation, mostly due to the acidic pH of this broth.

On the basis of the above, the expert discussed the matter repeatedly with the management at different levels in order to find a solution to this problem. Ultimately, Mr. Huo Xin-Yun suggested that the expert should visit the new workshop in order to study the steam seal of the $80m^3$ fermenters. Until this date, this workshop was not opened to any other foreign experts. Consequently, it appeared useful to deal with the steam seal/lock systems.

The fermenters are special reactors containing living micro-organisms while in operation. The aim of running such operations is to produce special organic compounds with these micro-organisms. In Wuxi Enzyme Factory, the specific aim is to produce different enzymes by using special culture techniques in the fermentation processes.

To achieve this goal, one has to ensure that special and well-defined living conditions for the selected micro-organisms are provided. Among other conditions, sterility is the dominant requirement for safe and productive operation. We have to assume that the general conditions are well defined and that the fermentation process began according to the standard parameters: the composition of medium is matching the prescription, sterilization is well performed, air supply is in order, agitation continues, instruments are in correct operational conditions. In most of the cases, the fermentation has to be continued for 72-168 hours. During this period, the purity of the culture should be maintained in the sense that contaminating micro-organisms could not enter into the fermenter. This is the basic requirement.

Contaminating micro-organisms can penetrate into the fermenter through different openings to the vessel, e.g. handling or main hole, sight glass, lamps, etc. Most of these openings can be protected easily by applying well-selected fix-sealing. A different situation would come up if any kind of pipe connection is joined to the body of the fermenter. Some examples of this kind of set up are: antifoam connection, joints to different chemicals, portholes for sampling devices, probes, etc. In general, one can solve these problems satisfactorily. The most common sources of contamination are: air intake piping, rotary shaft of the agitation system, and drain connection.

According to the expert's opinion, all these three sources of contamination in Wuxi can be regarded to as the main cause of the high contamination rate that is unacceptable to the current requirements. Contrary to this, the technical staff feels that the air supply is in order and therefore it could not be a source of contamination. The expert has doubts in the latter view and insists that the validation of air supply system should be carried out and eventually modern sterile air filters should be installed (from Pall, Dominick Hunter, etc).

As regards rotary shaft steam sealing and steam locks for pipe connections, the expert emphasized that the condition related to the present technical solutions is not acceptable. For this reason, the matter has been reviewed in the next chapter.

3.1 Rotary Shafts

Agitators with different profiles are used in mixing broth in the fermenters. A hole is made in the rotary shaft through the top or bottom plate of the vessel which connects the agitator with the driving motor. The vessel is normally a vertical cylinder that is considerably high. In order to mix the culture medium in the fermenter, a lot of energy is needed, and in order to transfer this energy, rotary shafts with respectively large diameter have to be used.

Due to air intake, a vibrating dynamic mass is filling up the vessel. Therefore, the mechanical fixing of the long rotary shaft by bearing house is a difficult matter to handle. It is in turn a complex task to seal the rotary shaft. The design of a fermenter bearing house and agitator shaft sealing, is indeed the key to contamination-free performance. Today, practically every fermenter is provided with dual-rotating mechanical seals for the rotary shaft. The mechanical seals per se do not provide a guarantee for sterility. If they do not get proper lubrication, their lives can be shortened considerably. Since no seal is 'optimal', the success of the sealing depends largely on the lubrication system applied. As far as lubrication is concerned, sterile steam condensate is safest not only because the lubrication problem can be solved in this manner, but sterility is also provided by the steam temperature.

Annex 2 shows a sketch of an agitator seal. The actual designs are more sophisticated, but the principle is the same, which is: for the lubrication, one has to use steam condensate and not the steam itself. The steam sealing is a system in which the lubricating chamber is not for the steam, but for its condensate. One has to use either a cooler outside the chamber to condensate the steam or, to have the system designed with double chambers whereby the outer chamber is furnished with water cooling. The steam no doubt prevents contamination, but does not provide proper lubrication. Dry steam may even make the surface of slipping rings become dry and thus causing the sealing surface to wear off. Furthermore, while heating up the rotary shaft, the steam itself also heats up the bearing house of the shaft, causing damages in the bearing house.

The expert feels that it is necessary to deal with this problem of the Wuxi Enzyme Factory in detail. This opinion was justified by the fact that

he encountered the very same problem even in the new workshop with the steam sealing system of the 80m³ fermenters. In the course of a visit with specific objectives, one can draw the conclusion that problems lie in the bearing house and steam sealing of the fermenters. The shaft (D=160 mm) rotates with 60-120/rpm and transfers 280 kw energy. The design, though modern and good, has two problems: firstly, the overheating of the bearing house results in inadquate greasing; and secondly, the double mechanical sealing also does not working properly. The expert only investigated the causes, but not the extend of the damage. One can observe the facts described below:

- The original drawings with incriptions in English were translated into Chinese. This translation unfortunately did not include the grade and specification of the heat resistant grease that was to be applied for the bearing house. As a result, ordinary bearing house grease was used instead of an appropriate one.

- The reason of overheating originates from the fact that during installation, the outer cooling chamber of the double mechanical sealing system was not connected with cooling water. This again can be explained by the translation problem. This is why the sealing system simply provided steam which heated up the slipping surfaces only, but did not lubricate them. For this reason, the bearing house of the shaft is being overheated.

In one case, we encountered a situation where no contamination occurred, but it became a severe source of potential damage. Here, the fermenters are on the contrary to the previous cases, either not provided with adequate steam sealing systems, or they were not used in the way that they were planned for. If this is true, then technological discipline should be applied to restore standard protection.

3.2 Pipe Connections

The possibility of back-contamination by steam, air and water service lines, as well as by the drain pipe must be considered seriously. Although steam pipe lines are self-protecting, problems may occur if there is a loss of pressure as a result of boiler failure or when pipelines at the interface with culture vessels are filled with condensate and water vapour at reduced pressure.

The connecting pipelines must be provided with steam seals or, as they are called in Wuxi, steam locks. Annex 3 is a diagram of the very commonly used steam seal arrangement. It is important that this unit be installed as near to the body of the vessel as possible so as to avoid dead spots. In general, this type of seals should be installed in such a way that back-flush can be avoided. The expert had the impression that, although this type of sealing system is known to the management, they might not fully understand the expensive consequences of its improper installations and handling.

IV. PILOT PLANT FERMENTERS

The term Pilot Plant Fermenter might have different meanings. In respect of its size and task, there is ample room for interpretation. The complexity of the theoretical approach of this problem can be simplified if one talks only about pilot size fermenters and not pilot plant fermenters. Large companies with sizable fermentation capacity have separate pilot plants with fermenters of various sizes that address different needs.

In the culture maintenance laboratories, usually small bench-top fermenters are used to study the growth parameters. In Wuxi, the expert was informed that such facilities are not yet available, but the people expressed the wish to possess pilot size fermenters and would also like to manufacture these technical units locally. It was on the basis of this concept that the visit to Chengfeng Furnace Co. Ltd. was organized. After having examined the situation at the site, the expert proposed to build some simple bench-top fermenters at first. These should be made with top and bottom plates in stainless steel, and walls with glass cylinder. This type of vessels can be installed within a very short time. With the installation of these units, the staff can at once start working to gain knowledge and experience in fermentation processes.

These bench-top fermenters are also useful in another respect: to optimize different parameters of the fermentation process. Other advantages are that the operational costs are inexpensive and that they do not need spacious laboratories. The pilot size fermenters should be acquired either parallel with the small bench-top fermenters or only at a later stage. One has to take into account several points when considering the need and the purpose of using pilot size fermenters.

The above description on the size of the pilot plant fermenters is only one aspect of the matter. Other even more important aspects are for example, instrumentation and control. Piping is another very complex part if one takes into consideration that both the quality and quantity of output of the pilot size operation should meet the requirements. All in all, the instrumentation, piping and control are much more difficult and expensive elements of the fermenters than the body itself. According to the expert, a fully furnished pilot plant fermenter with instruments, up-to-date piping, and control facilities, is what Wuxi needs.

4.1. Research Work

Pilot plant fermenters for research work in almost all sizes are being offered by different producers. One leading manufacturer of fermenters, MBR Switzerland, offers the following product line:

- Small bioreactor: mini 2,5 L
- Laboratory bioreactors:
  with glass cylinders - 5, 7, 10 L
  with stainless steel cylinders - 12, 15, 18, 20 L
- Pilot size fermenters: 150, 300, 750, 1500, 3000 L
- Production bioreactors: up to 30,000 L

4.2. Scale-up of Production

For the scale-up of production of certain products, one has to use relatively bigger pilot fermenters: 75, 150, 300 L (e.g. from CHEMAP, Switzerland). As a matter of fact, fermenters that are slightly bigger (750, 1000, 3000 L) are being used for the production of fine chemicals.

The principle of scaling-up production is that the volumes of the fermenters should be selected in such a way that a correlation of parameter values measured between pilot and industrial fermenters is obtained. The correlation with fermenters of very different sizes cannot be obtained since the time of heating, cooling, the deviation from set values, etc., differ widely due to the significant differences in the mass transfer. Therefore a particular size of fermenters is required so that one can obtain useful data for projecting the parameters of fermentation at a larger scale.

V. TECHNICAL SPECIFICATION OF A 75 L PILOT PLAN FERMENTER PROPOSED BY A YOUNG TECHNICAL STAFF OF WUXI ENZYME FACTORY

In Annex 4, a sketch of this fermenter with general data is shown. Based on the approval of this proposition by the management, the expert has demonstrated the basic designs of a 300 L pilot fermenter, taking into account the above considerations and his previous experience in this field.

VI. BASIC DESIGNS FOR A 300 L PILOT SIZE FERMENTER

6.1. Vessel with D/H ratio 1/3 (see Annex 5)

The vessel has a removable flat cover which is fastened to the vessel by means of C-clamps. The sterile seal is ensured by an O-ring and the cylindrical part of the vessel is surrounded by a heating jacket. The cover, the bottom plate and the vessel wall are equipped with standard nozzles and fittings. The penetration of the harvest valve is located on the lowest point of the vessel bottom dished head, allowing complete drainage:

- working pressure vessel/jacket 3 bar;
- vessel material 316 L (1.4435) stainless steel;
- vessel jacket 304 (1.4301) stainless steel;
- vessel inside surface 220 grit;
- vessel outside surface 180 grit, pickled.

6.2. Table of Connections (see Annex 6)

This table contains the proposed standard nozzles and connections for fittings with their position and specification.

6.3. Bottom Design (see Annex 7)

The bottom plate is made into a dish form by machine instead of using pressed dish bottom.

6.4. Double Mechanical Seal (see Annex 8)

The seal has the following options:

- Carbon/cast chrome for both of the seal rings at the processing side as well as the non-processing side;
- SI carbide/SI carbide for seal rings at the processing side and carbon/cast chrome at the non-processing side.

6.5. Steam Lock of Mechanical Seal (see Annex 9)

A sterile condensate piping is installed for the lubrication of the double mechanical sealing of steam pressure regulator, sight glass, steam traps, further automatic and manual diaphragm valves and steam filter.

6.6. Air Inlet System (see Annex 10)

The air inlet system of the fermenter is designed for the sterile aeration of the culture media via the sparger or via the head space. The piping consists of:

- in situ sterilizable absolute filter element;
- completely drainable stainless steel housing;
- steam, air connection;
- possibility for additional gas connections;
- diaphragm valves.

6.7. Exhaust Gas System (see Annex 11)

The basic exhaust gas system consists of:

- heating element with manual steam valve and steam trap;
- diaphragm valves for sterilization;
- back-pressure control valve.

6.8. Harvest System with Steam Lock (see Annex 12)

This consists of diaphragm valves for steam, and condensed water for harvest.

6.9. General Piping and P & I Diagram (see Annex 13)

This drawing contains the piping system with standard symbols of fittings and probes for instrumentation. It is a proposition for piping and instrumentation of a fully automated pilot fermentation system.

This part also contains a summary of Annexes 5 - 14.

VII. RECOMMENDATIONS

7.1. The Reconstruction Programme of Enzyme Production

The expert understands that both the construction and present operation of the 60m^3 fermenters in the old workshop, together with the construction of the new workshop with 80m^3 fermenters, are steps being taken towards a systematic reconstruction programme of the enzyme production at Wuxi Enzyme Factory.

Attention should be drawn to the fact that the installation of new 60m^3 fermenters using the old air supply-system and feeding facilities is not safe and cannot be maintained for a longer period under such conditions. If, moreover, the new workshop is to be operated with the same supply systems, the situation would be even worse and yet new facilities will be needed again within a very short time. Therefore one should compare the cost of energy and raw material wasted, or it would even be more appropriate, to compare the investment expenses with the value of enzyme production lost. The return of investment value should not take more than 2 to 3 years. It is therefore worthwhile to make a thorough calculation and take necessary action promptly.

7.2. Manufacture of Pilot Size Fermenters

The expert personally supports the idea that under present circumstances, the Wuxi Enzyme Factory mostly need bench-top and pilot size fermenters. The body of such fermenters could be manufactured by local suppliers. There are doubts, however, as regards piping with proper valves and instrumentation, especially in respect of control. The Wuxi Enzyme Factory will have to arrange with other Chinese institutes and companies for the instrumentation and control, whereby the choices are very limited in this field .

It is therefore considered better and cheaper to buy good quality second-hand fermenters from the open market. Annex 14 gives details on a Swedish company which offers exactly the type of pilot fermenters that the Wuxi factory would need.

It would also be recommendable if Swedish experts could, at the request of UNIDO, visit the site and make a survey for this offer. In any case, UNIDO could request for quotation of a 150 L CHEMAP fermenter with control system.

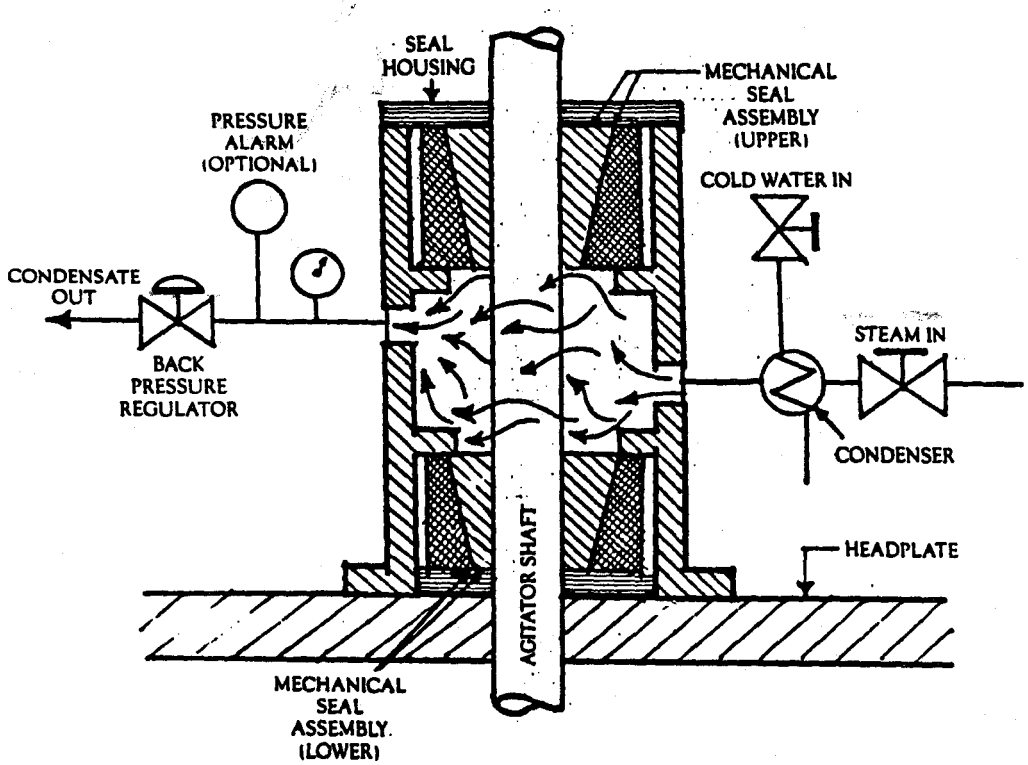
Z. Csizer/l.g.
2 February 1993

JOB DESCRIPTION
DP/CPR/88/001/11-58

Post title	Industrial microbiologist/engineer.
Duration	3 weeks (inclusive travel time)
Date required	ASAP
Duty station	Wuxi, Jiangsu Province, People's Republic of China
Purpose of mission	Improvement of Technology for Production and Development of Enzymes at Wuxi Enzyme Factory.

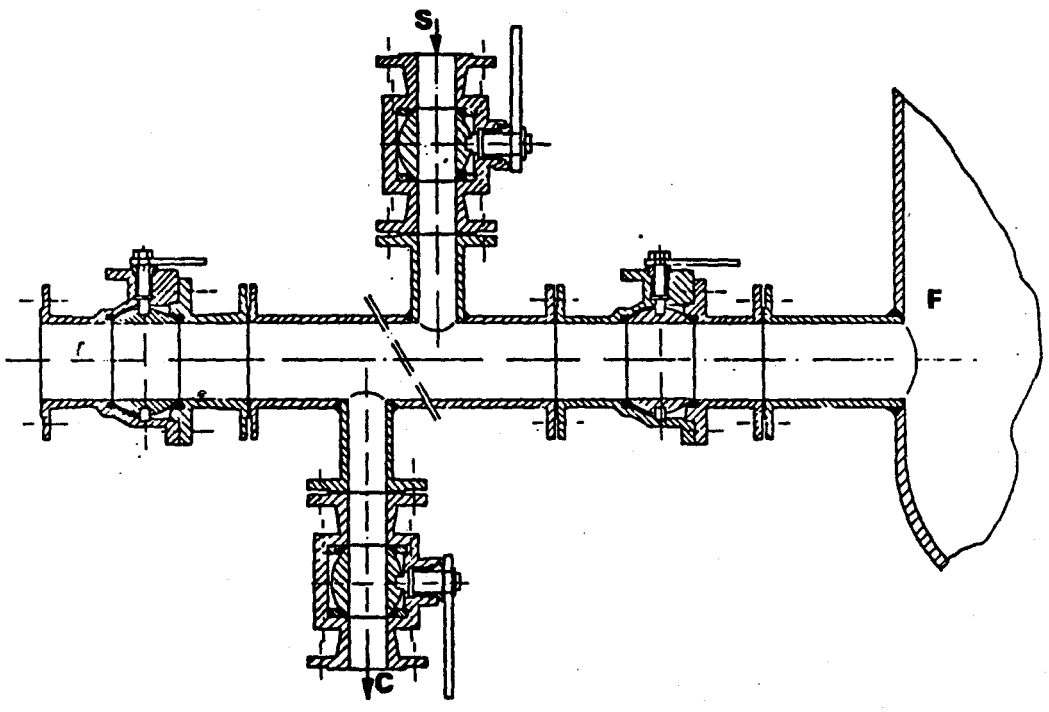
Duties

1. Assess and review maintenance facilities at the Wuxi Enzyme Factory
2. Assess and review engineering facilities at the Wuxi Enzyme Factory.
3. Assess and review fermentor manufacturing workshops.
4. Assess and review raw materials, parts, instrumentation, etc. locally available for domestic manufacture of fermentors.
5. Prepare engineering drawings of a fermentor prototype for enzyme manufacture.
6. Give detailed specifications of the above.
7. Prepare a technical report with recommendations.

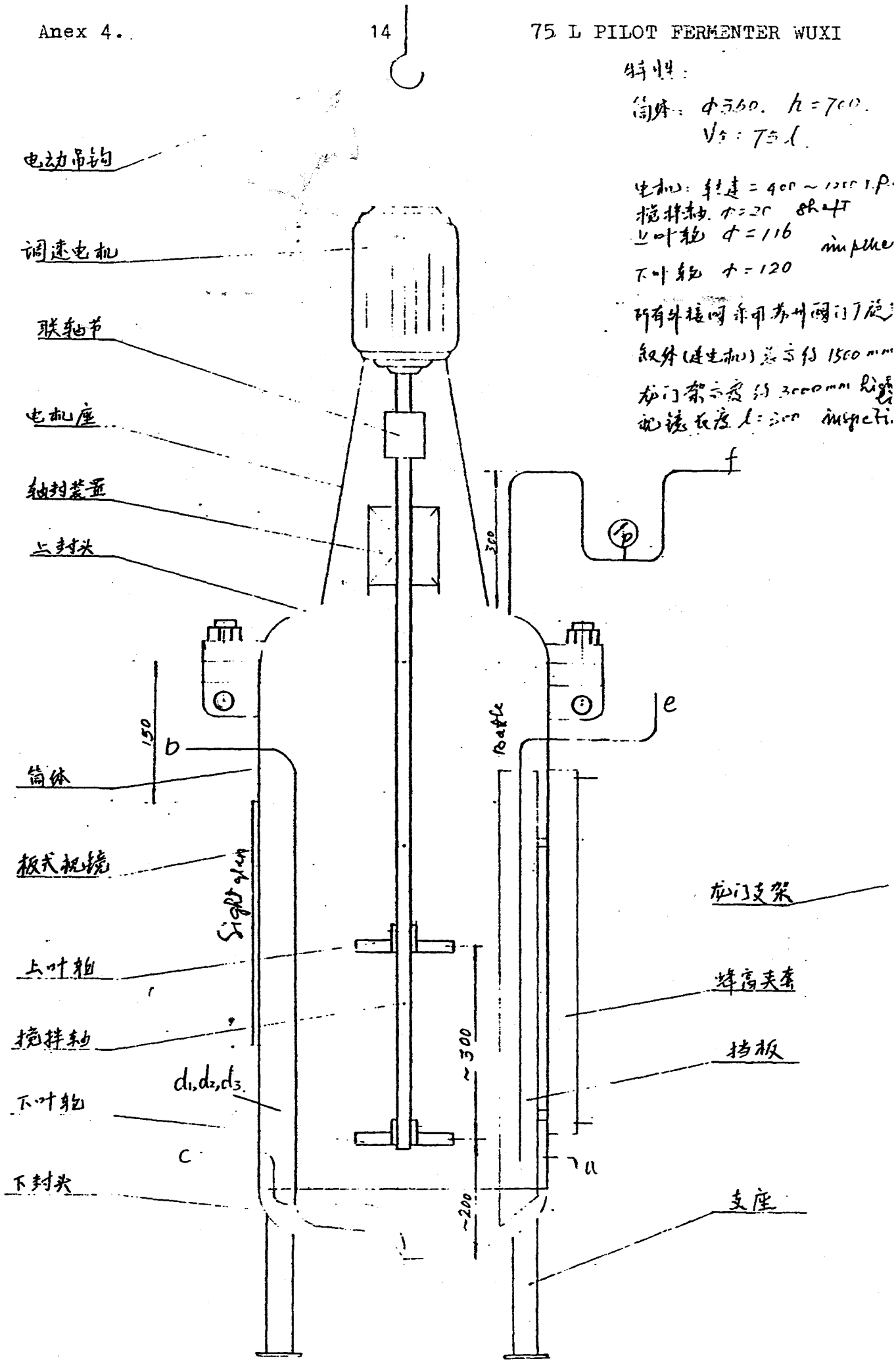


Top Drive Agitator Seal (Bottom Similar)

Annex 3.



A steam seal. S, steam; F, fermenter; C, condensate.



特性：

筒体：ϕ500. h=700.

V公：75 L

电机：转速 = 400 ~ 1200 r.p.

搅拌轴 ϕ=20 shaft

上叶轮 ϕ=116 impeller

下叶轮 ϕ=120

所有外接阀采用苏州阀门厂的

取样(进出料)管高约 1500 mm

挡板架高约 3000 mm 长

电镜长度 L=300 magnetic

Materials of construction:
- Shell: 1.4435
- Jacket: 1.4301

Surface finish:
- Inside: polished 220 grit
- Outside: polished 180 grit

Design conditions for shell and jacket:
- Temperature: 150 °C
- Pressure: 3 / -1 bar (g) // 45psig / full vacuum

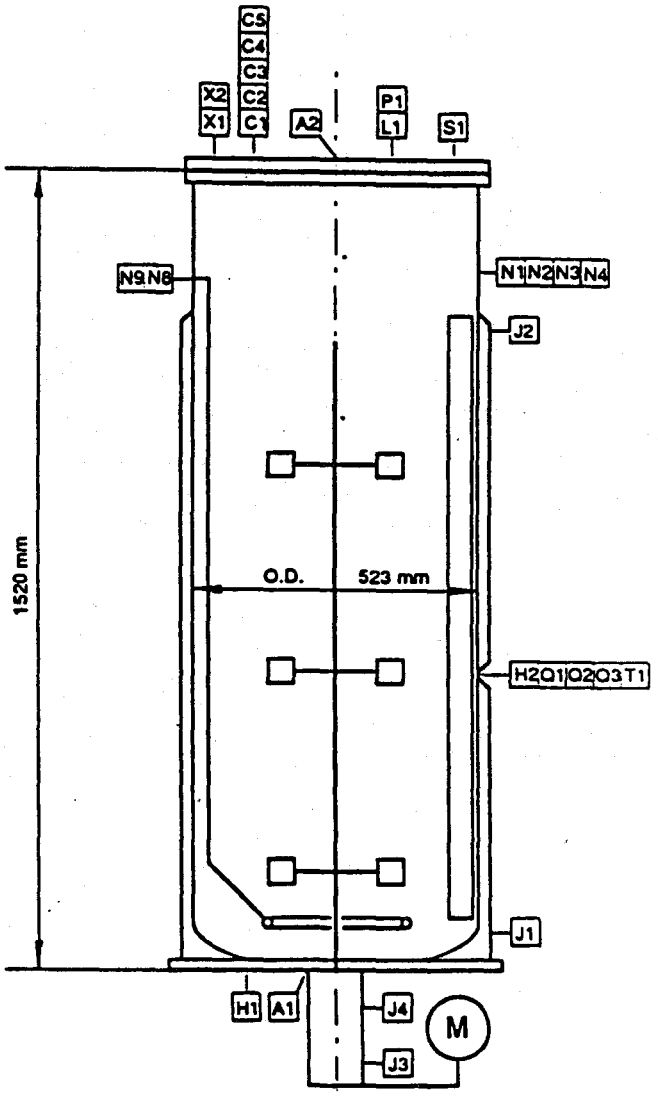
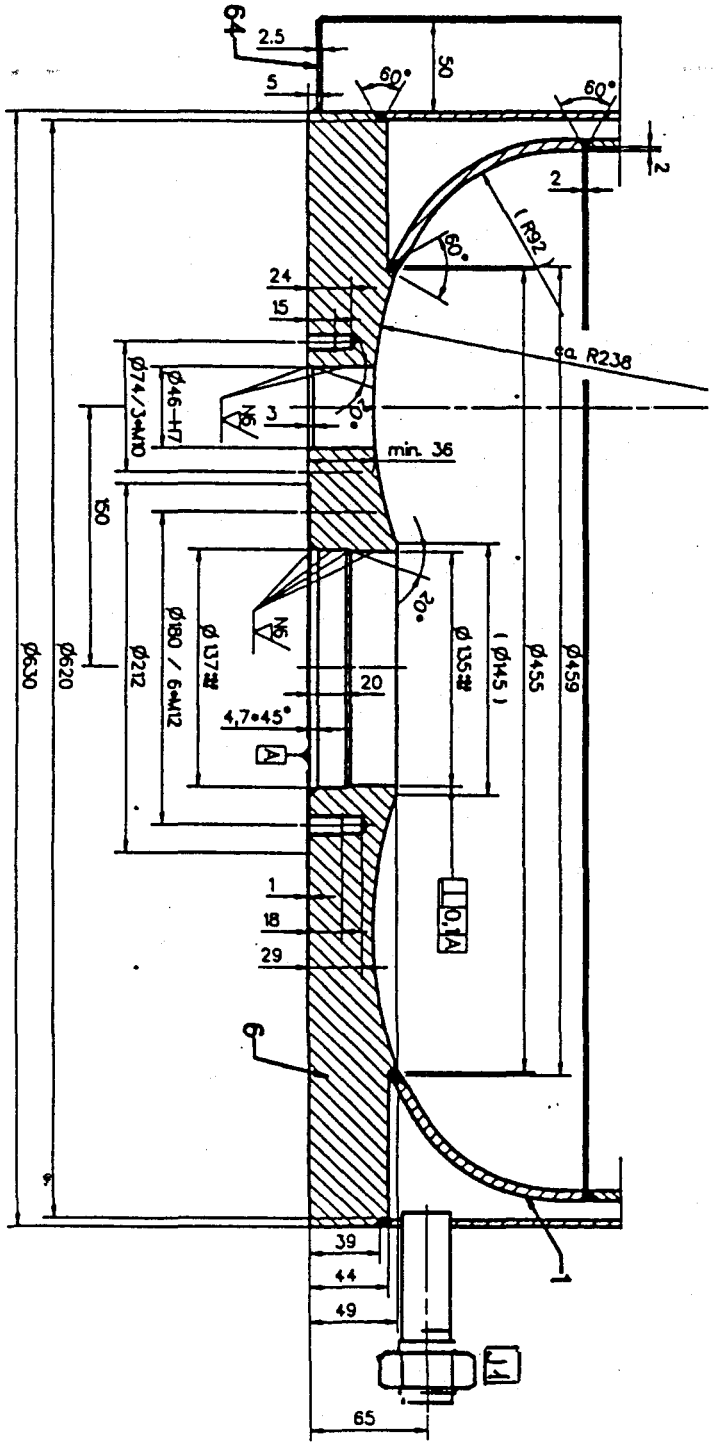


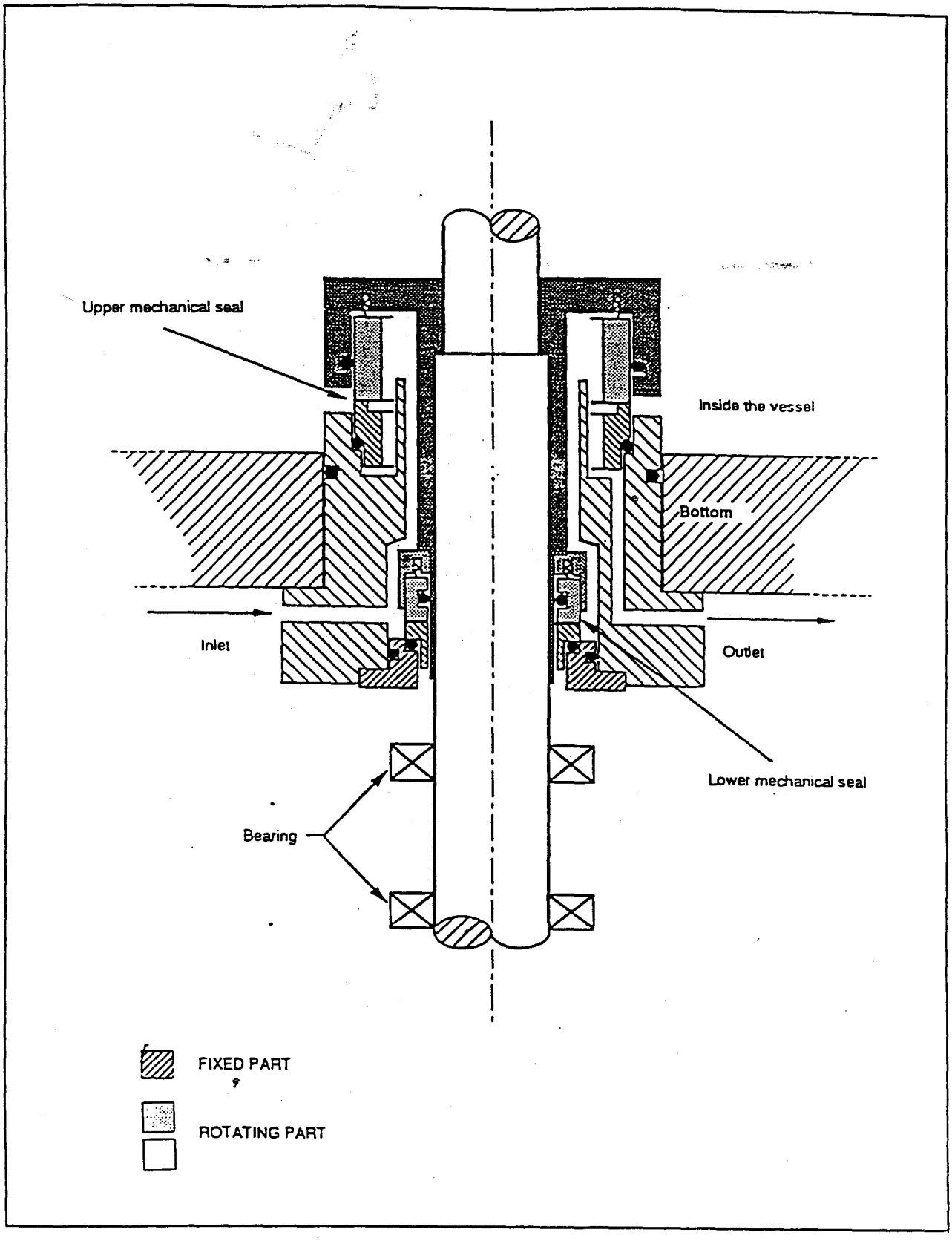
TABLE OF CONNECTIONS

ID	Qty.	Size	Description	Service	Drawing no.	Remarks
A1	1	O. D. 137 mm	Connection	Agitator		
A2	1	O. D. 90 / DN 20	Connection	Air exhaust		
C1	1	DN 8	inlet	Steam flush sight glass		
C2	1	19 mm	Connection	Needle/SACOVA conn.		
C3	1	19 mm	Connection	Needle /SACOVA conn.		
C4	1	19 mm	Connection	Needle/SACOVA conn.		
C5	1	19 mm	Connection	Needle/SACOVA conn.		
H1	1	O. D. 46 / DN 25	Outlet	Harvest valve		
H2	1	25 mm	Outlet	Sample taking		
S1	1	DN 25	Outlet	Rupture disc		
X1	1	O. D. 100 mm	Outlet	Light glass		
X2	1	O. D. 71 mm	Flange	Sight glass		
L1	1	19 mm	Flangel	Level probe (foam)		
J1	1	DN 25	Inlet	temperature circuit		
J2	1	DN 25	Outlet	temperature circuit		
J3	1	DN 8	Inlet	Condensate / steam		
J4	1	DN 8	Outlet	Condensate		
N1	1	25 mm	Inlet	Acid		
N2	1	25 mm	Inlet	Base		
N3	1	25 mm	Inlet	Nutrient		
N4	1	25 mm	Inlet	Antifoam		
N9	1	25 mm / DN 15	Inlet	Air to sparger		
N8	1	DN 15	Inlet	Bypass		
P1	1	19 mm	Instrument	Sterile pressure gauge		
T1	1	25 mm	Instrument	Temperature element		
Q1	1	25 mm	Instrument	pH probe		
Q2	1	25 mm	Instrument	dO2 probe		
Q3	1	25 mm	Instrument	spare		

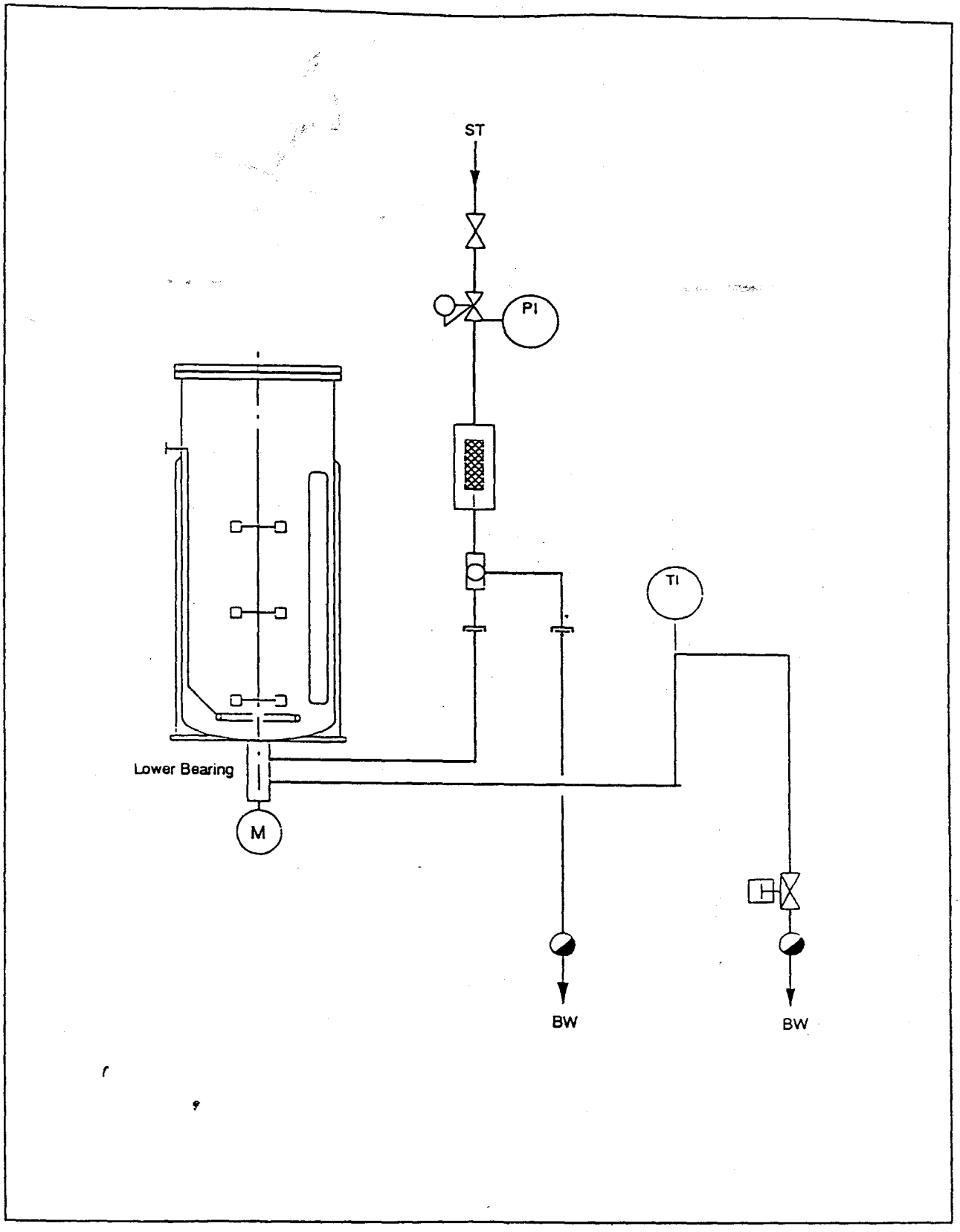
NOTES:

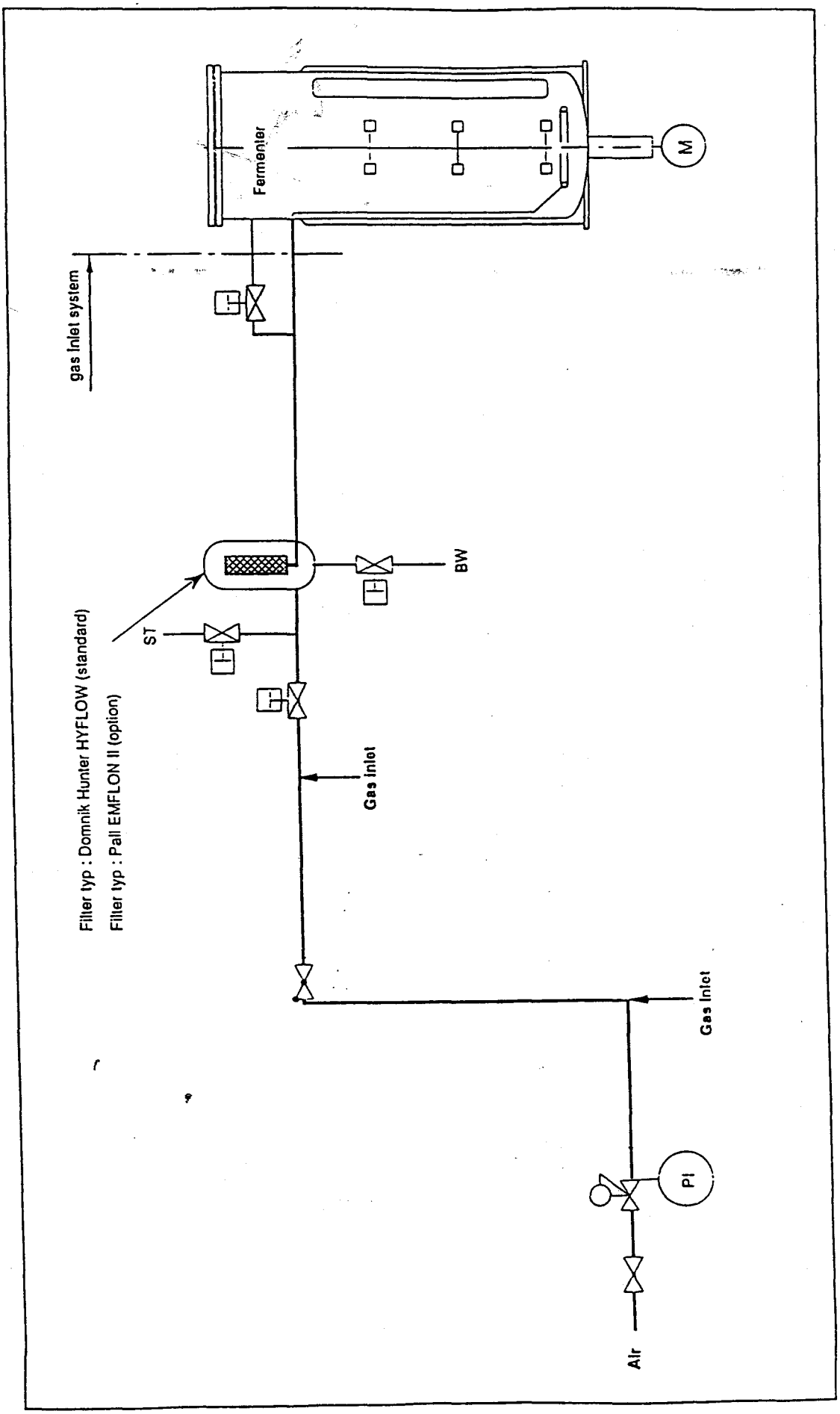
VESSEL BOTTOM DESIGN

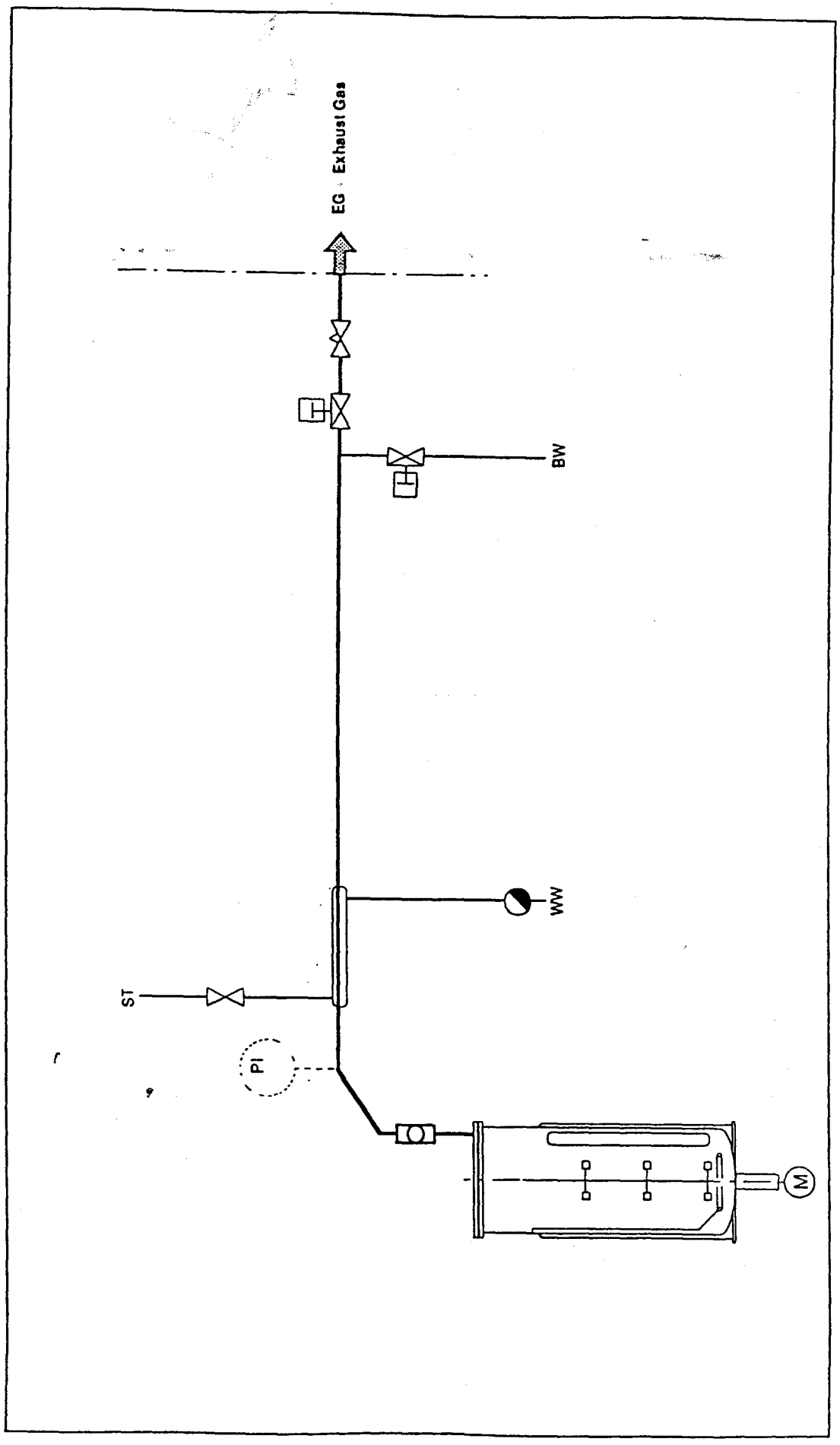


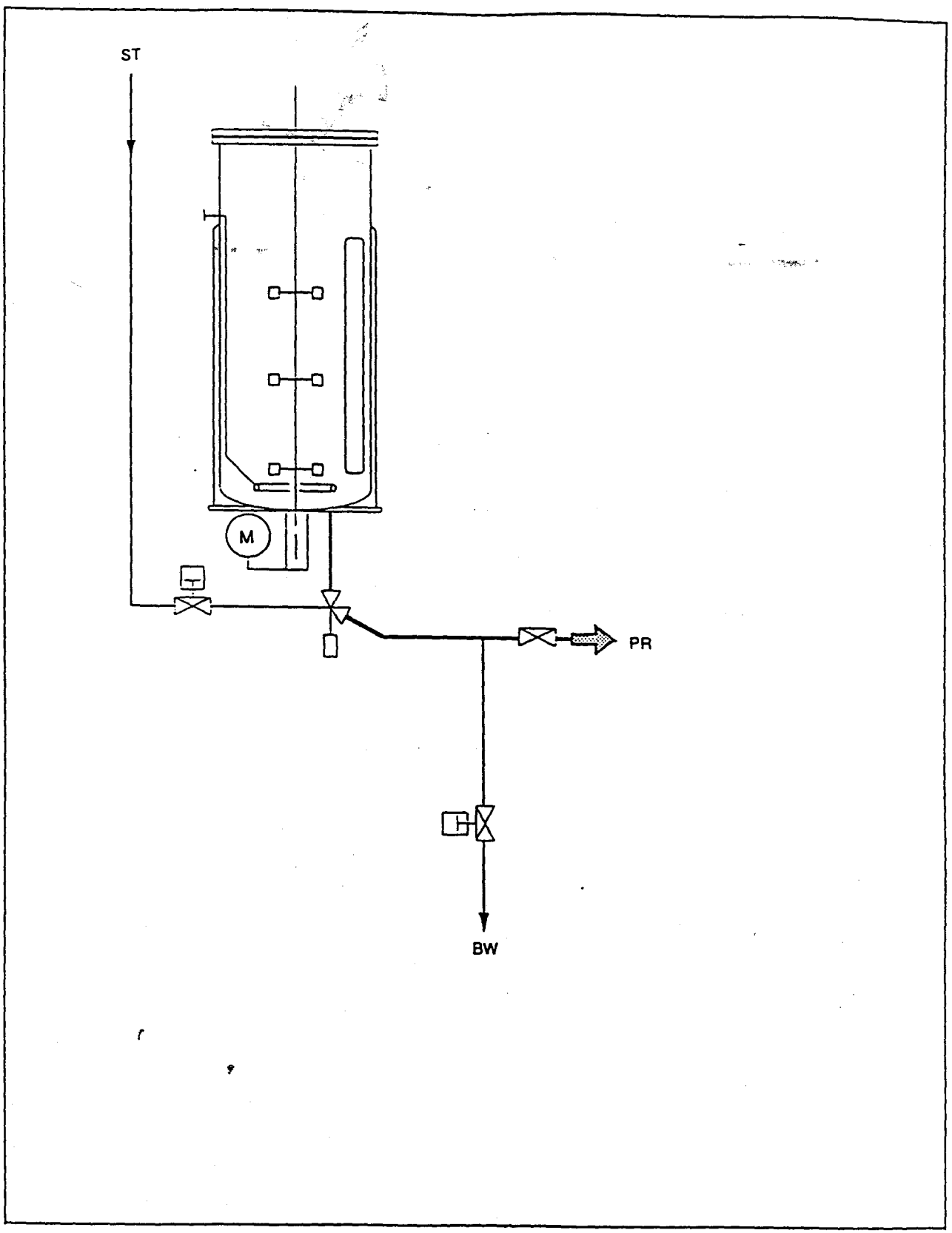

Upper mechanical seal
Inside the vessel
Bottom
Inlet
Outlet
Lower mechanical seal
Bearing
FIXED PART
ROTATING PART

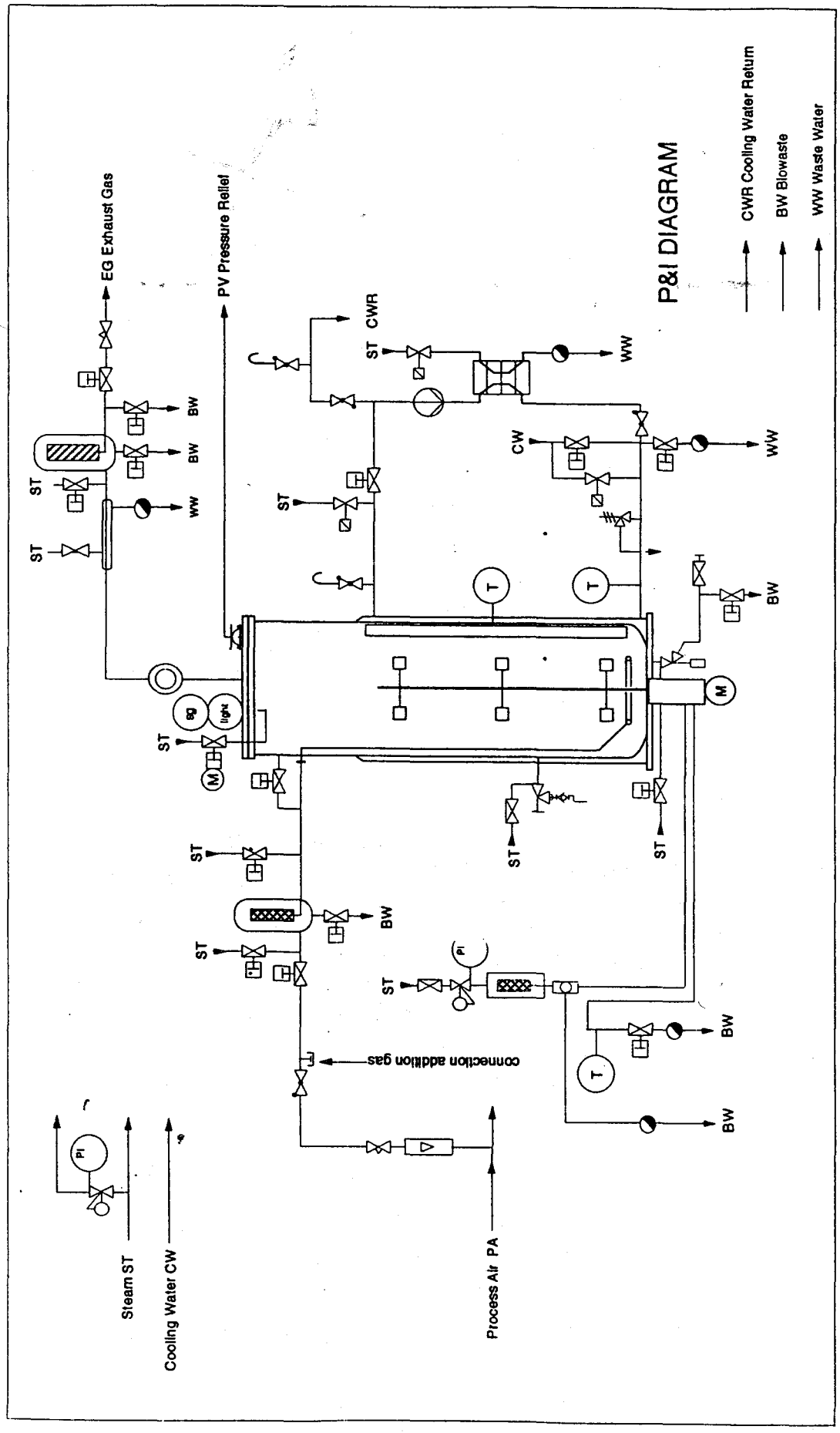
Annex 9. 19 STEAM LOCK OF MECHANICAL SEAL




Fermenter
M
gas inlet system
BW
ST
Filter typ : Domnik Hunter HYFLOW (standard)
Filter typ : Pall EMFLON II (option)
Gas inlet
Gas inlet
PI
Air


EG - Exhaust Gas
BW
WW
ST
PI
M


ST
M
PR
BW


P&I DIAGRAM
CWR Cooling Water Return
BW Blowaste
WW Waste Water
EG Exhaust Gas
PV Pressure Relief
ST CWR
WW
CW
BW
ST
T
M
PI
connection addition gas
Steam ST
Cooling Water CW
Process Air PA

DEAR SIR,

WE WOULD VERY MUCH LIKE TO GET IN CONTACT WITH YOUR COMPANY.
OUR ASSORTMENT IS VERY WIDE, A GOOD PART OF SWEDISH/SCANDINAVIAN SURPLUS.
FOR LABORATORY: ALL KINDS OF ANALYTICAL INSTRUMENTS AND UTILITIES.
FOR PRODUCTION: ALL KINDS OF EQUIPMENTS FOR USE IN THE FIELDS OF: MEDICINE AND PHARMACY, MILK, BREWERY, FOOD AND CHEMICAL INDUSTRY.

For exemple:
CENTRIFUGE-SEPARATORS AND -DECANTERS(ca 100 ex), BASKET AND PUSHER-CENTRIFUGES, EXTRACTORS AND EVAPORATORS: all sizes of ALFA-LAVAL CENTRITHERM evaporators.
TANKS, REACTORS, FILTERS, MIXERS, FERMENTORS also in high-resistant materials. DESTILLATION EQ.
PRODUCTION LINES FOR WOOD PULP, GLYCERINE, EXTRACTION, HYDROGENATION...
ELECTRIC POWER PLANTS (to 6 MW), HEAT PUMP STATIONS (to 1½ MW)
BULK SUCTION HARBOUR UNLOADING EQ.

PLEASE LET US KNOW WHAT YOU NEED-- AND DO NOT FORGET TO TELL US WHAT YOU CAN SELL OF YOUR SURPLUS EQ.

WITH THE GREATEST RESPECT I SIGN

SINCERELY YOURS Hans Malmberg e.a.

Annex 15.

COMMENTS OF UNIDO's SUBSTANTIVE BACKSTOPPING OFFICER

This is a very brief report of the expert who has a lifetime experience in biotechnology, and particularly in fermentation. In this concise paper, he gives the most essential elements for a technically viable fermentation, which eventually might also lead to economic viability.

One of the main conclusions that one can draw from reading the report is the importance of human resources development. It is known that through the process of information delivery or exchange, essential pieces of know-how might be missed due to the inadequate quality of communication, interpretation or translation, therefore one of the main tasks for the professional staff at Wuxi Enzyme Factory should be, the English language training. The fermentation technology and the downstream processing technology are developing rapidly, but new formulae and materials are being developed even more rapidly for upstream and downstream processing. Without an updated technical library, it seems to be very difficult to cope with the adaptation of newly introduced materials and techniques. It is therefore highly recommended that at least a few relevant periodicals, international scientific and technological papers in English should be subscribed.

A second comment would be to emphasize the importance of setting up a workshop not only for repair and maintenance of the fermenters, but also for the manufacture and installation of the most important parts and spares parts required.

Thirdly, it would be a very good idea to establish a Chinese association of biotechnological/fermentation industry that could address issues of common interest such as the acquisition of new technologies, adaptation of new equipment, materials and techniques, introduction of process validation, etc. As an alternative recommendation which could be implemented immediately, Synder Co. Ltd. should be approached to provide support to the sustainable development of the joint venture, which would mainly require updated technological information.

Finally, the report proves UNIDO's competence to make significant contribution to improve manufacturing processes and consequently achieving results with very limited resources via the services of international consultants.