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UNITED NATIONS
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Workshop on Maintenance and Plant
Inspection in Petroleum Refineries

Vienna, Austria, 17 February - 7 March 1986**

REPORT*** of the Workshop on Maintenance & Plant Inspection in Petroleum Refineries.

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I. PREAMBULE

UNIDO, in co-operation with the Austrian Government, the state-owned petroleum company Osterreichische Mineralöl Verwaltung (OMV), and the OPEC Fund for International Development, has since 1981 organized four Workshops in Vienna on Petroleum Refining Industries:

a) Workshop on Petroleum Processing, 21 - 30 April 1981;

b) Workshop on Production Planning and Energy Management in Petroleum Refineries, 3 - 14 May 1982;

c) Workshop on Maintenance and Plant Inspection in Petroleum Refineries, 5 - 23 September 1983;

d) Workshop on Maintenance and Plant Inspection in Petroleum Refineries, 5 - 23 November 1984.

The topic of the Fifth Workshop on Petroleum Refining Industries, held from 17 February to 7 March 1986, in co-operation with the Austrian Government and OMV, was Maintenance and Plant Inspection in Petroleum Refineries.

The programme of the Workshop consisted of:

- Lectures;
- Practical demonstrations on site;
- Visits to Austrian manufacturers;
- Question and Answer Session;
- Experience Exchange Group.

II. INTRODUCTION

It was decided to repeat the topic of previous workshops, because of the interest shown by participants in the problems related to maintenance and plant inspection and because of the importance of this issue to petroleum refineries in developing countries, in terms of the age of some of the installations, low operating rate and lack of skilled personnel.

We have taken into account all suggestions, comments and recommendations of the preciding workshops to present a programme which would cover items of major interest.

We have resisted the temptation to split the programme into two seperate items, i.e. maintenance and inspection; the two functions are interrelated and are often combined in the developing world due to the lack of specialization within these fields.

Apart from the lectures, the programme has given more emphasis to practical on-site demonstrations and to visits to manufacturers and specialized technical centres in Austria. A larger part of the programme has bee allo-

cated to the Experience Exchange Group, in which outside specialists and consultants have led and moderated discussions.

III. OPENING SESSION AT UNIDO HEADQUARTERS (17 February 1986)

The opening speech was delivered by Mr. A. Vassiliev, Director of the Department of Industrial Operations, UNIDO. Mrs. A. Tcheknavorian-Asenbauer, Chairperson and Head of the Chemical Industries Branch, UNIDO, welcomed the participants jointly with Mr. W. Lichem, Alternate Permanent Representative of Austria to UNIDO, Mr. H. Kaes, Director General of the OMV Aktiengesellschaft, and Mr. H. Lederleitner, Austrian Federal Economic Chamber.

The participants were then taken to the OMV-Refinery in Schwechat for the duration of the workshop. A brief introduction to the OMV Aktiengesellschaft was made by Mr. Cech, Director of the Refinery. The lecturers were then introduced and the current status and activities of the Refinery were made known. Following the detailed workshop programme, the participants were requested to submit questions which had not been covered by the lectures. These questions were then dealt with in a special Question and Answer Session before the close of the Workshop.

IV. PROGRAMME AND SUMMARY OF THE LECTURES

(The Programme of lectures started in the afternoon of 17 February 1986)

1) PLANT INSPECTION

Plant Inspection (Lecture by Mr. O. Hornasek, Head Refinery Maintenance, Division Plant, Inspection Department)

Points covered during this lecture were:

- Corrosion Problems in Petroleum Refineries

  The Schwechat Refinery prevents corrosion through the reduction of moisture, de-aeration, control of pH, control of temperature, inhibitors, control of specific corrosive concentrations, hydrogen blistering control, anodic protection, design, materials selection and protective coatings. Based on typical refinery equipment failure due to corrosion, alternatives and programmes were discussed.

- Scheduling Equipment for Inspection

  - o Statutory inspection due to local government regulations (Austrian Pressure Vessel Law)
  - o Equipment in corrosive/non-corrosive service
  - o Fired boilers, unfired pressure vessels
  - o The necessity of periodic shutdown for cleaning, maintenance and repair.

- Inspection Methods

  Visual inspection (VT)
  Hammer testing
  Nondestructive testing by Ultrasonics (UT)
  Radiography (RT)
  Eddy current (ET)

Dye penetrant (PT)
Magnaflux (MT)
Acoustic emission (AE)
Infrared scanner (IR)

Cleaning for inspection, metal loss measurements, corrosion rate measurement, pressure testing, (acceptable chloride content), leakage testing.

- Deterioration and Failure of Equipment and its Prevention

Discussions took place on mechanical causes of failure, corrosion and oxidation in process furnaces (headers, tube supports, hangers) thermocouple sheaths, exchangers, condensers and coolers.

Other topics covered were constitutional failure in materials due to environment, hydrogen blistering promoted by unclean, laminated material, tank bottoms of storage tanks, spheroidization of carbides and graphitization in carbon and low alloy steels in high temperature service.

- Prevention of Failures

Dual layer ceramic fiber wall replacing common refractories. Steel-Iron Shipping Conditions 072/1977 of the German Steel Producers Organization "Requirements for Testing Metal Sheets/Plates by Ultrasonic Means" must already by applied during fabrication of refinery equipment.

- Lifetime of Equipment

Based on federal regulations and the Austrian Pressure Vessel Law, the lifetime of fired heater tubes and equipment exposed to an elevated temperature above +450°C should be calculated with a limited life of 100,000 hours (i.e. 11.2 years). Determination of the life expectancy of a plant operating at high temperatures was illustrated in two cases:

Platforming HEATER B 403 and FCC REACTOR D 601

The calculation of heater tube thickness was carried out according to API RP 530. The Reactor Vessel was operated for 140,000 hours at a temperature of approximately 510°C and a pressure of approximately 1.7 bar. Material of the shell was 15 Mo 3 (carbon steel), no high temperature corrosion occured.

- Detailed Equipment Inspection

General safety precautions, nomenclature, design and retirement criteria materials of construction, inspection, repair and testing of columns, pressure vessels, storage tanks, heat exchangers, cooling towers, process furnaces and boilers, piping, structurals, fireproofing, insulation, foundations and lifting equipment were discussed.

- On-stream Inspection and Special Testing Methods

Visual Inspection

Introduction and Basics of Ultrasonics

Acoustic couplant, crystal and ultrasonic equipment for on-stream inspection at elevated temperatures up to +420°C.

Refractory and insulation inspection by thermovision.

Radiography and leakage detection on storage tanks for liquid hydrocarbons by means of acoustic emission. Latter was presented as well at the NPRA Maintenance Conference held February 18 - 21, 1986 in San Antonio, Texas, USA.

- Special Schwechat Refinery Problems and their Solution

Corrosion control in OMV distillation units by chemical means.

Corrosion monitoring by corrosion coupons and corrosion probes, and their principles.

Cladding and corrosion spools as an alternative in vessels.

Waste water lines (weakly HC-contaminated surface-, rain- and turn-around waters):

Design criteria,
old/new standard, corrosion
protection by Insituform:
Polyester felt hose with a
laminated PVC-Foil soaked
in epoxy resin in an inside-
out position.
Hardening (reticulation) is
carried out at 140°F (60°C)
with heated water.

- Corrosion Protection by Organic Layers (Paint)

If surface preparation and application of paint is not carried out according to a proper specification, the organic layer will fail as a permanent barrier against the corrosive environment. To fight atmospheric corrosion, a total film thickness of 200 microns (8 mils) minimum is required, especially if corrosiveness and high humidity prevail.

Excessive thinning of high quality materials is a well-known cause of low quality performance. The bondage fo the embedded pigments is decreasing rapidly, giving the material a "porous" structure causing pinholes, a decline in water vapor, diffusion resistance, shorter paint life, and finally, advanced rusting.

Applicable details were specified.

- Workshop Including Practical Demonstration of Selected NDT Techniques

  Setting and calibration of instruments, testing of prepared specimens, and on-site survey of refinery equipment.

  Methods applied:

  Ultrasonics
  Thermovision
  Acoustic Emission
  Leak Detection
  Tracer Method
  Fiberscopy
  Magnetic Particle Testing
  Eddy Current Inspection
  Corrosion Monitoring
  (Probes/Coupons)
  Alloy Analyzing

- On-Stream Methods

  - Ultrasonics
  - Thermovision
  - Acoustic Emission
  - Leak Detection
  - Tracer Method
  - Radioisotopes in fault finding and process characterization

2) Plant Inspection (Material Standards) Lecture by Mr. H. Raaber, TUV

Introduction:

Presentation of the lecturer and the TUV (Technischer Uberwachungsverein = Technical Inspection Association). TUV's function in Refinery Schwechat. Some remarks concerning Austrian legislation on pressure vessels, showing personal authorization of the lecturer.

General summary of existing material standards with special consideration of Austrian standards.

Pressure parts in refinery service: Fired heaters, columns, pressure vessels, steam boilers, heat exchangers, water and air coolers, connecting pipes.

Main problems involved in material selection:

High and low temperature, high pressure, high pressure in hydrogen atmosphere, different kinds of corrosion, erosion and combination of these factors.

A short glance at the materials frequently used in the refinery:

For general service (temperatures up to approx. 400°C): carbon steel, low alloy steel.

For high temperature service: Low alloy steel, chromium steel, austenitic steel for extremely high temperatures (e.g. centrifugally cast tubes for ethylene cracker).

For low temperature service: Carbon steel, nickel steel, austenitic steel for low temperature service, aluminium alloys.

For high pressure: Materials with high allowable stress values are not very common in use for refinery purposes.

For services under high pressure in hydrogen atmosphere:

Chromium steel.

For service under corrosion-causing circumstances:

Corrosion-resistant alloy steel and austenitic steel, plated carbon steel, pressure vessels with different linings. Brass and bronze for tubes and tube plates of heat exchangers. Water coolers with ceramic surface protection.
Erosion problems are mainly managed by doubling the wall at steam exposed parts of pressure vessel.
Calculating methods for wall thickness and the difference between the European philosophy and the American solution, i.e. a great amount of testing is done and small safety factors are used in calculating, whereas the opposite applies concerning American standards.
Very high standards of quality in construction of pressure vessels in Austria. Excellent welding quality results in low risk of defects under service condition.

Inspections: At least every three years all pressure vessels are opened for internal inspection and every six years hydraulic tests are executed.

2) MAINTENANCE

Maintenance (Lecture by Mr. J. Maier, Head Refinery Maintenance Department)

- Total Maintenance Function

  It embraces all personnel and activities related to refinery maintenance, i.e. engineers, inspectors, planners, workshop and craftsmen. They have an important part to play in the optimization of maintenance costs, and collaborate with the production people as determined by the overall maintenance policy.

- Works Shut-Down

  The most important maintenance activities are carried out off-stream. The planning of the programme and the time and manpower scheduling, resources and equipment planning techniques are discussed and the techniques used in the Schwechat Refinery shown. Network-analysis methods with the help of standard networks are presented.

- Maintenance Strategies

  The fundamental types of maintenance strategies are discussed and where they should be used to obtain optimum maintenance and production results.

- Maintenance by Contractors

  It is normally carried out in each refinery. The extent and type of application of contractor work depend largely on local conditions and on the overall maintenance policy of the company concerning availability and safety of the refinery units. Backgrounds are discussed by the lecturer.

  - A Maintenance Information System and a Work-Order System are important to keep all maintenance activities under control.

    The elements of such a system were discussed in general and, in particular, the Schwechat Refinery's computer-aided system was presented, covering:

    - o Job evaluation and work-load control of workshops;
    - o Work order cost control;
    - o Maintenance costs for particular objects;
    - o Total plant maintenance costs;
    - o Annual maintenance costs;
    - o Computer-aided information systems for routine maintenance and inspection results.

  - Maintenance Organization

    The different types of organization are discussed with the advantages and limitations of each type of chart.

  - Tools and Equipment

    In larger refineries, tools and equipment must be mobile and area-oriented, and not centralized in workshops.

    The problems of idle and travelling time and the methods to reduce these losses are discussed.

Maintenance of Rotating Equipment, Compressors, Turbo-machinery (Lecture by Mr. H. Miglitsch, Head Refinery Inspection Department)

The manufacture and maintenance of turbo-machinery are completely different. The first involves the shaping and assembling of various parts to required tolerances, while the second involves restoration of these tolerances through a series of intelligent compromises. This is the crux of maintenance technique - keeping the compromises intelligent.

The process industry has pushed for bigger and better turbo-machinery. The development of better maintenance and trouble-shooting techniques is essential as is the feedback of this experience to the manufacturers of the equipment.

The lecturer discussed the ways and means of avoiding sources of trouble or a checking system if trouble occurs:

1. Vibration monitoring - monitoring systems of today.
   An ultra-modern system used in the Schwechat Refinery was presented.

2. Rotor-dynamics, balancing of rotors.
3. Alignment of machines (hot and cold).
4. Bearing design and the influence on vibration level.
5. Vibration standards.
6. Shock-impulse measurement of ball and roller bearings in pumps.
7. Considerations of oil systems and their reliability.

There are often no simple solutions to the maintenance and technical difficulties we face in the petroleum industry. Technical training, selection of machines and parts, and reliability studies are essential to success in this field.

Maintenance of Instrumentation, Pneumatic, Electronic Instruments (Lecture by Mr. H. Kloyber, Head of Instrument Department)

An overview was given of the organization of the Instrumentation Maintenance Department, its activities, and typical problems associated with maintaining process instrumentation.

Basically activities may be devided into:

A) Maintenance during shut-down periods
B) Maintenance while plant is in operation

A) Maintenance During Shut-Down Periods

All instruments have to be checked in accordance with a standard "STOP PLAN". This stop plan consists of several groups of instruments, i.e.:

i) Field Instruments

- o control valves
- o transmitters
- o orifices
- o level switches
- o i/p converters

ii) Control Room Instruments

- o controllers
- o alarm and cut-off systems
- o recorders

B) Maintenance While Plant is in Operation

- o If a unit leader or an operator suspects an irregularity, he demands our checking the instrument in question.
- o Repairs of damaged instruments as far as possible while plant is in operation.
- o Preparatory work for next planned stop.
- o Assistance to be given to the "Austrian Board of Weights and Measures" when gauging storage tanks and volumetric meters.

In order to obtain a standardized instrumentation system, OMV has set up its own OMV STANDARD. Whenever a new plant is being projected, they try to adopt OMV STANDARDS for instruments. This is done for the following reasons:

a) They already have had experience with such "standardized" instruments.

b) It is known that these instruments will work well without a great amount of maintenance and repair for several years.

c) The more standard instruments are used, the less wider and varied experience is required from their maintenance personnel.

It is of great importance such a standard is up-dated every few years, so that the latest "state-of-the-art" can be taken into consideration.

The maintenance strategy for process analyzers is completely different from that for other instruments. They need a permanent, all year round maintenance to obtain good availability. The maintenance intervals result from OMV's own experience and from the service information given to them by the manufacturer.

OMV has compiled a maintenance list for each analyzer consisting of:

- Type of analyzer
- Specification of analyzer
- Maintenance required daily/weekly/monthly
- Maintenance required during stop.

A "failure range of tolerance" has also been set up for each type of analyzer. Periodically our laboratory makes analyses of a sample taken from the process analyzer sampling system. If the results of the laboratory are within this tolerance range, we say that the process analyzer works precisely. If not, the process analyzer has to be re-adjusted or repaired.

Today, we have an average availability of about 95%. By the end of 1982 we had approximately 500 analyzers, including gas detection systems. On account of this great number, each instrument worker is specialized in several types of instruments only, which is more effective. In spite of a growing number of instruments (in 1977 69 analyzers, presently 500), we now have only 55% more instrument workers for process analyzers. On average, each instrument worker has to maintain about 30 analyzers.

3) ENERGY CONSERVATION IN THE REFINING INDUSTRY (Lecturers: B. Kögl, Head of Economics Department and D. Taylor, Economics Department)

This lecture presented an overview on the energy balance of the Schwechat Refinery.

Other possible areas where energy recovery measures could yield high savings were discussed and energy conservation projects realized in the refinery were presented. The Energy Consumption Monitoring System used in the refinery was described, together with the overall energy concept,

and especially the function of energy management in the organization of the refinery. The programme comprised:

- Introduction;
- Energy conservation - General methods of energy recovery and energy saving;
- Energy management and its position within the organization of the Schwechat Refinery;
- Collection and compilation of data on energy consumption;
- Technological measures on energy recovery taken or proposed in the Schwechat Refinery;
  - o Increase efficiency of heaters
  - o Computerized control
  - o Optimization of exchanger trains
  - o Low temperature waste heat recovery

4) ANALYTIC TROUBLE-SHOOTING, PROBLEM SOLVING AND DECISION MAKING (Lecture by Mr. H. Huber, OMV, Head of Training Department)

The seminar presented methods and techniques facilitating choice and use of relevant data in problem solving, decision-making and crisis prediction. It showed how complex situations could be better handled when broken down into parts. With regard to daily routine work, four models of reasoning are used:

- Determining reasons for trouble,
- Choice of best possible measures to be taken,
- Anticipation of problems which might arise,
- Splitting complex situations into parts.

Therefore, the following questions were put before the seminar participants:

- What action should be taken in the case of trouble?
- How can trouble or deviations best be described?

The question as to the "reasons for trouble" and the determination and checking of those reasons was also discussed.

As far as Decision Making is concerned, the following was discussed:

- within the framework of a decision-analysis
- the description of the reason for a particular decision
- the preliminary decision, and, finally
- the checking of negative results.

Prediction of future problems under the heading "What could go wrong if certain measures were taken?" were described, based on an analysis of potential problems.

Knowledge of this "ATS"-Method is of special importance in the field of MAINTENANCE, in order to increase efficiency.

V. VISITS TO AUSTRIAN COMPANIES (26 February 1986)

- Elin is the most important electric power engineering company in Austria. It is active in the field of power plants, transformers, switchyards, electrical equipment, electric welding, installation and illumination.

  After an introductory film on Elin lectures were given on:

  - Activities with OMV (especially electrical sub-stations, generators, transformers),
  - Automatic loading stations for filling of petroleum products (on rail and road),
  - Motor drive techniques for asynchronous motors.

  A visit to a design department and research laboratory then took place.

- Simmering, Graz and Pauker (S.G.P.) is a well-known enterprise in heavy industry with long experience in rail vehicles and it was interesting to note its production of goods wagons like pressure gas tank wagon, liquid tanks for the oil industry

  - in power stations,
  - industrial plants (boilers, columns, piping, ...),
  - hoisting hear, gear units,
  - machinery and internal combustion engines (steam turbines, fans, condensers).

- Austrian Central Welding Institute (20 February 1986)

  The Austrian Central Welding Institute has basic training programmes, research activities and testing means. This institute has excellent facilities for welding and well-equipped dynamic testing laboratories. Training programme includes the most up-to-date welding developments, and a research programme is currently undertaken on behalf of large industrial companies.

- TUV (Technischer Uberwachungsverein)

  This was a practical demonstration on storage tanks (mobile trailer on site). TUV Vienna uses the theory of acoustic emission testing (AET), which is a non-destructive method utilizing acoustic emissions generated by regions of discontinuities in a structure to assess the physical integrity and/or tightness of that structure. This is a very convenient method which was used at Schwechat refinery for the tests of over 50 storage tanks with various diameters of up to 57 meters, and we had a good opportunity to evaluate this method.

- Visit to the Computer Section at Schwechat Refinery, where all information regarding warehousing and stores control are centralized.

- Visit to Central Technical Department of OMV in Gerasdorf (central maintenance and repair shop), 4 March 1986.

- Visit to the Austrian Chamber of Commerce (25 February 1986)

  The purpose of this visit was to introduce some of the Austrian manufacturers active in this field of industry.

- Voest-Alpine (Mr. Pilz, Knes and Pezendorfer)

  Information was obtained on different production lines and services of this leading company in Austria, through the Division of Metallurgy, Processing, Finished Products and Services. This group employing about 70,000 people is involved in plant operation (more than 100 plants and production facilities), engineering and construction (more than 400 plants delivered and installed throughout the world and operational and management assistance (servicing, inspection and repair). The management service is of special interest in this field.

- Böhler Vereinigte Edelstahlwerke AG (Mr. Türk and Rippel)

  This company is part of Voest-Alpine group and produces actuators and positioning systems for all types of valves and equipment for the chemical and petrochemical industries, such as heat exchangers, reactors, columns, high pressure valves, fittings, pumps, etc.

- Hoerbiger Ventilwerke (Mr. Pedit)

  This is a reputable producer of plate valves and control systems for piston compressors.

- Worthington GmbH (Mr. Grohmann)

  Worthington GmbH is a famous manufacturer of all types of centrifugal pumps used in refining industry.

- Rosenbauer is an Austrian firm specialized in fire-fighting (portable fire pumps, mountable pumps, monitors, vehicles and extinguishing agents).

VI. QUESTION AND ANSWER SESSION

(5 March 1986)

A whole day was allotted to this session with a view to covering questions raised which had not been specifically dealt with during the course of the lectures.

Below is a random sample of questions and answers dealt with during the session, conducted by Messrs. Maier, Hornasek and Miglitsch:

1) Short lifetime due to corrosion (both sides, but especially from the inside in the heater tubes of the reformer heater of the H2 generator). Operating conditions: 950°C - 2 bars. The generator is heated by fuel gas with some sulfur content.

2) - Catalytic reforming reactor (UOP process)
material of body/overheated at top, refractory damaged at 390°C.
- How to inspect cold shell reactors?

3) - Inspection of heat exchanger bundles inside tubes - proceedings.
- Catodic protection of underground pipeline in a refinery.

4) - Instrument compressed air contaminated by water and oil.
- Cleaning of tanks (short and safe) for crude, gas oil; floating and fix roof - temperature problem in summertime.
- Reactor of the performer: operating at 400°C. A crack in the shell of one in a set of four. Is the change of all necessary?

5) - Sealing of gasoil pumps at high temperature (about 200°C)?
- Sealing vacuum bottom pump packing at re-starting in the asphalt unit.

6) - How to set inspection programme for stationary equipment?
- How to set closing pressure of a safety valve during operation?
- What is the best way to clean heat exchangers?

7) Refinery closed down in 1981, situated near the sea.
Corrosion inside/outside. How to inspect?
(Presentation of Shell-Programme: Comments by OMV). This subject was brought up to the Experience Exchange Group.

8) - Heat exchanger of hydro-cracker. Methods for prevention, cleaning. Precipitation of polyaromatics.
- Techn. procedure or material for refractory problem. Replacement of lining.
- Bolts on high pressure exchanger - short life-time because of heavy stress.

9) - Cathodic protection of underground line, corrosion internal.
- How to localise corrosion in piping.
- Pitting in certain tubes (small diameter).

10) - Running over 100% capacity: What effects on the equipment?
- Seawater impact to the pumps (sand particles).
- Tank cleaning.
- Erosion in distillation at tube bundles at feed-in (changed every 6 months).

11) - Abnormal corrosion in cooling water system (soft water) after a few years of operation.
- Blistering problems in hydrogen containing equipment.
- Tank cleaning (crude oil).
- Cont. catalyst regeneration,
Cracks at HAZ (heat affected zone).

12) - Cracks on crude heat exchanger shells (from side to side - radial)
Floating tube exchanger - 250°C after 4 months of operation.

- Tank farm (painting of production tanks - inside)

- Furnace stacks: How to inspect?
40 m high, no flanges
Selection of paints (high temperature)

- Fractioning columns, how to inspect internally (after 15 years of operation)?

- Heat exchangers - selection of size during design.

- Steam boilers (water tube b.)
Air preheaters 500°F
Not more than 1 month's operation.

- Equipment replacement policy.

- How to install a training department in a refinery organization.

- Spare parts problem: procurement, specifications, drawings, obsolete equipment.

- Alignment for big equipment: steam turbines, electrical drivers, ...

13) - FCC unit. How to clear the coke from the bottom lines (diameter 12")

- Heavy catalyst lost due to wrong operation of flapper valves in the regenerator FCC unit.

14) - Contamination of sludge in vacuum units.

15) - Naphta hydrobon (heat exchanger/no spare bundle).

16) - Hydrogen blistering in vessels, columns (unit cannot be stopped).

- Torque techniques (unibon).

- Acoustic emission techniques used in refining.

- Boiler economizer (external corrosion), 50 t/h each.

- Safety valves, hot setting on boilers.

17) - Avoiding maintenance problems within a newly built refinery.
Precautions at the design stage.

18) <u>Spare parts and replacement parts</u>

It was mentioned that delivery for replacement parts from one manufacturer is often too long, and that equipment was no longer manufactured. Because of the depression in the refining industry in Europe and the USA, a substantial second hand market exists for large and small items of equipment, a possibility well worth considering before making a decision.

VII. THE EXPERIENCE EXCHANGE GROUP (6 - 7 March)

The purpose of this session was to give the opportunity to the participants to work as a team on a practical case faced in one of the refineries, and the way in which the problem was tackled. It was very often established that the cases are very similar and problems could be solved more easily without the pressure of production department, lack of special tools or material, or missing spare parts. The group worked as a "brain trust" and the assistance of experts from developing countries brings in more confidence because of similar cases experienced in other developing or developed countries.

Mr. Maier, Head of Maintenance and Inspection at Schwechat Refinery, Messrs, J. Vandeven and J. Estrugo from UOP (Universal Oil Process, USA) and Mr. S. Winton from Bechtel (UK) assisted at this session. Below is a sample of "situations" in given countries presented for discussion, in some cases accompanied by technical data, calculation sheets and photographs.

Participant from Qatar:

In one section of the naphtha Hydrobon plant, a number of tubes developed inner corrosion, which caused a complete shutdown. Provision of spare U-tubes requires 6 months. In the meantime it was decided to isolate the faulty section, bringing down the operating rate to 60%. What could have been done? Why was a better system of isolation of each section not incorporated in the design?

Participant from Ivory Coast:

Difficulties in repairing cracks in refractory inner of some of the equipment like hydrogen plant furnace, transfer lines, etc. Methods used described in this case, but are there any standard procedures and specific materials for such repair work?

Participant from Argentina:

The unexpected short life of reformer tubes for a steam reformer furnace (hydrogen generator). Characteristics of tubes, operating conditions, heating fuels are given. Since start-up of the furnace the tubes have suffered damage, which has caused many shut-downs, and required several replacements. The expected life-time of 10 years has not been met (the average being three years). All incidents were recorded since 1971. Advice on action to increase the life-time period was discussed.

Participant from Ghana:

The problems of corrosion at the Tema Refinery are critical. The plant was built in 1963 on the coast where the atmosphere is very humid and seawater is used as a cooling system. There is a need to devise means, like the provision of zinc anodes, to fight corrosion effects.

Participant from Jamaica:

Pump sealings: The problem is that the vacuum pumps may be the source of loss vacuum via their packing. There are however no visible signs of packing leakage but to be on the safe side, pumps are often re-packed or

the packing re-tightened. What are the positive means of testing/identifying leaking pump packing in vacuum service?

Participant from Jordan:

The Jordanian refinery experienced hydrogen blistering in the shells of vessels and columns. Since spares were not available locally, it was decided to run the units and keep regular checks on these vessels by ultrasonic measures of thickness. How safe is it to keep the vessels running and are there methods other than ultrasonic techniques to keep the vessels under check and control?

Another pending question in this refinery is fastener tightening control techniques using hydraulic wrench and bolt gauge to control and tighten the bolts. Because of different manufacturers and different batches, results were not always convincing. Similar techniques used elsewhere were discussed in this connection.

Participant from Malaysia:

What means can be employed to properly clean heavy scale deposit on metal surfaces of water-cooled heat exchangers? A hydrojetting method was recommended by the manufacturer but was not enough, so a complementary rodding method was used. These combined methods cost more time and money. Is there any other quick and cheap method used elsewhere?

Participant from Togo:

The situation of Lomé refinery was presented to the participants as a case study. This refinery started up in late 1977 and had accumulative operation of about 2 years before closing down in 1981 for non-technical reasons. A conservation programme was agreed upon with a subsidiary of the Shell Company. The programme of conservation was presented during the session and action regarding maintenance and inspection of equipment and materials were commented upon.

Participant from Benin:

The case of Benin is different. Because of promising discoveries of crude oil, it is planning the construction of a refinery. With regard to maintenance and inspection, what are the precautions to be taken at an early stage for the design and construction of a very simplified process, e.g. a hydroskimming refinery, with an optimum capacity for a given range of products. Ideally what would be the choice of process, equipment, materials, spare parts, tools, training etc.?

These two last examples offered an opportunity to recap on the different problems faced by different operators, to summarize what is likely to be foreseen, and what is part of the industrial risk inherent in any operation.

VIII. DISCUSSION AND CLOSING SESSION (7 March 1986)

The purpose of this session was to discuss workshop results and follow-up activities. The participants had the opportunity to express their opinion on the organization, arrangement and content of the programme.

Organization

The dedication of the lecturers and support staff of OMV was emphasized on all occasions, and the organization was considered to be very good throughout.

Programme

In confirming with the resolutions passed at the last workshop, more time was given to practical on-site demonstrations, outside visits and direct contact with OMV specialists in the refinery. The number of lectures was kept to an optimum and some topics were added, like Energy Conservation or New Technology in Petroleum Refining to familiarize the participants with the new technologies.

A recently acquired film on fire in a South England petrochemical plant was shown.

Information and material brought back by OMV from a US seminar on Maintenance and Plant Inspection was communicated to the participants. A display of recently acquired monitoring equipment and devices used in maintenance and inspection was also organized.

Many participants recommended continuity in programme content and in participation, while others favoured the introduction of new items on the agenda, e.g.

- Spare parts management,
- Reconditioning of spare parts,
- Regional information centre and central repair shop.

Timing

It would be fair to report that participants complain about weather conditions at this time of the year in Austria. Because of annual shut-down of the refinery and holiday period for personnel and production constraints, it was very difficult to plan another period for this year. But it is still possible to move towards spring time for the next workshop.

Actions

The situation regarding maintenance and inspection at petroleum refineries in developing countries could be alleviated if certain conditions were fulfilled, e.g.:

- Training of skilled personnel in specialized areas of maintenance and inspection;
- Possibility of exchanging specialists during turn-around maintenance periods when a larger number of personnel is required;
- Setting up a spare part service or a central repair workshop on a national or regional basis;
- Organization of a tight system of tests, both ex-factory and on-site, before acceptance of equipment and material;
- Acquisition of control instruments and devices to monitor performance of equipment and material.

Recommendations for future technical co-operation

During the course of the workshop, through presentations made by the participants and discussions held on an individual basis, we were able to identify a large number of fields of possible co-operation. UNIDO procedures for official requests, channels of communication to be used, and sources of financing to be explored for individual technical assistance projects were explained. A type of regional assistance was deemed the most suitable to optimize the expert and advisory services that UNIDO would provide and bearing in mind the mutual problems and interests of the industry.

IX. CLOSING CEREMONY

This session was introduced by Mr. M. Maung, Senior Industrial Development Officer of UNIDO, who then gave the floor to Mr. A. Vassiliev, Director of the Department of Industrial Operations for the closing speech.

Deep appreciation was expressed, once again, to the staff of OMV, to the organizers and the sponsors, who had conducted the Fifth Workshop and brought it to a very successful conclusion. It was also an opportunity to compliment the 22 participants coming from 19 countries for their competence and zeal. As Heads of Maintenance, Inspection or Technical Services Departments in their respective countries they have a large responsibility for the running of their units. About 100 participants have attended previous workshops who were able to transfer experience and technology to their colleagues. At the same time a continuous exchange of information among the participants themselves, as between the participants and the organizers, had been established.

Statements were also made by Mr. W. Lichem (Alternate Permanent Representative of Austria to UNIDO), Mr. F. Cech (Director of Refinery, OMV Aktiengesellschaft) and Mr. G. Tscherne (Austrian Federal Economic Chamber), who expressed their thanks to the participants and organizers of the workshop, which marked an important milestone in technical co-operation with developing countries.

ANNEX

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