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ENGLISH

United Nations Industrial Development Organization

Technical Consultation on Corrosion
in Fertilizer Plants

Sandviken, Sweden, 27 - 31 August 1979

REPORT*

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CONTENTS

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REPORT

Addendum

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At the end of paragraph ii) add The articles referred to can be found in Chemical Engineering, 12 February 1979 and 12 March 1979:

INTRODUCTION

1. Organization of the Consultation Meeting

In accordance with the resolutions of the Industrial Development Board of UNIDO, which stressed the need for training of national personnel for industrial development, UNIDO together with the Arab Federation of Chemical Fertilizer Producers (AFCFP) held a Seminar in Baghdad, Iraq, in March 1978, on Key Factors of Raising Productivity in Fertilizer Plants. It was a result of this Seminar that UNIDO proposed to SANDVIK AB to hold this Technical Consultation on Corrosion in Fertilizer Plants.

The programme for this Consultation was sponsored through contributions in kind by SANDVIK AB together with the Swedish Corrosion Institute. Financial assistance and support was also obtained from the Swedish International Development Authority (SIDA).

The Consultation Meeting was attended by sixteen participants from ten different developing countries. The Industrial Development Centre for Arab States (IDCAS) representative, Mr. Jasim M. Ganim, attended the meetings as an observer. SIDA was represented by Mr. L. Lindblad.

The technical programme was planned by SANDVIK AB in close co-operation with UNIDO. Mr. C. Keleti, Senior Industrial Development Officer, Chemical Industries Section, was officer in charge on behalf of UNIDO, with Mr. W. Kamel representing Non-Governmental Organization and Business and Industrial Institution Co-operation Section of UNIDO. The meetings were chaired by Mr. Nils-Göran Persson of SANDVIK AB.

The consultations included the following activities:

The first two days were devoted to a series of lectures at Steel Research Centre of SANDVIK AB:

- corrosion resistance and testing methods;
- quantitative metallography in production control;
- mechanical properties and testing methods;
- welding methods and materials.

It was combined with visits to the research laboratories at the Steel Research Centre. Two days were devoted to reviewing materials problems in some basic processes and to the presentation of seven papers by the participants on corrosion problems in their respective plants. Countries presenting papers included Bangladesh, China, India, Indonesia, Kuwait, Mauritius and Saudi Arabia.

During these sessions the participants also had the opportunity to visit part of the SANDVIK steel melting and tube production plants. The fifth day was spent in Stockholm with the Swedish Corrosion Institute (SCI) during which sessions were devoted to atmospheric corrosion, corrosion inhibitors, anti-rust painting and a visit to the SCI laboratories.

II. Country papers

As an introduction to the presentation of country papers SANDVIK gave a status report on each individual process and the materials problems associated with it.

Ammonia Plants

Bangladesh

Mr. M.D. Sayeed presented his paper ID/WG.305/5 on the Ghorasal 660 MT/D ammonia/urea plant. In his presentation he pointed out several process design bottlenecks as well as corrosion and fouling problems experienced at the Ghorasal plant. In particular he mentioned the reformed gas waste heat boilers where fouling occurred frequently after start up of the plant due to pluging of the header, drain leakage of tube sheets of the methanator effluent economizer and frequent failure of welding joint in the elbow portion of the outlet line from the methanator. Welding joint also failed in the inlet of the synthesis economizer at the outlet of synthesis converters. He also listed a number of tube failures in heat exchangers. Amongst the remedies he listed preventive measures taken at the plant against corrosion. These included

a) the use of pentavalent arsenic in solution as per design, maintaining chloride and iron content in solution at design values;

b) the use of limited dose of hydrazine in the BFW after deaerator to minimize dissolved oxygen;

c) the addition of polyphosphates to the boiler;

d) the addition of chlorine and polyphosphate chromate to the cooling tower.

China

Mr. Yilie Zhong of the Chemical Industry Design and Engineering Institute presented a paper on "typical equipment corrosion phenomenon in large scale ammonia plants" ID/WG.303/4.

In this presentation the following were reviewed:

a) Reformer tube failures:

b) Reboil[illegible] corrosion:

c) Circulating water pump corrosion.

In the discussion that followed, it was pointed out that in case of reformer tubes emphasis should be given on material selection for the tubes, the manufacturing and welding procedures to be used and inspection techniques developed and available to estimate the residual life of the tubes as follow up of the case study presented in the paper.

In case of the circulating pump consideration could be given to use AlSi-414 or Ni-Resist iron could be an answer to the pump impeller.

India

A case study on the stress corrosion failures in reformer furnace components was presented by Mr. C.V. Srinivasan of Madras Fertilizer Limited, ID/WG.303/3.

In his conclusions he pointed out that heat treatment of the stub and weld zones to mill-anneal temperature (980°C) is practical and would considerably bring down the residual stresses. The residual stresses will be less than 20 per cent of the yield stress. The method appears to be an effective way to reduce the incidence of stress corrosion in the future.

In the discussion that followed it was pointed out that a likely possibility of dew point condensation existed causing stress corrosion failures.

Indonesia

In absence of Mr. U. Sumitro, his paper on the corrosion of CO_2 stripper gas reboiler in P.T. Pupuk,Sriwidjaja, was presented by SANDVIK representative, ID/WG.303/2.

During the discussion that followed, it was pointed out that the problem in the stripper or reboiler is generally due to the higher temperature ($> 120^{\circ}C - 130^{\circ}C$) which may result in concentration, loss of inhibitors and also higher velocities. The remedy thought by the author of the paper was to install a restricting orifice at the liquid inlet nozzle to increase the total liquid flow on the "hot end" of the reboiler. This correction will be evaluated during the next shut down in 1980.

Urea Plants

Mr. Lundell of SANDVIK reviewed the experience in a paper presented on urea. He reviewed the historical background of

a) Total recycle process;

b) Improved total recycle process (Montedison);

c) Stripper process (Stamicarbon,

" " (Snam Progetti).

In close co-operation with Stamicarbon SANDVIK developed a stainless steel 2RE69(25Cr/22Nr/2.1Mo/N) for stripper tubes resulting in a following experience:

- The presence of oxygen in the process solution will keep down corrosion rate by keeping the stainless steel passive;
- Increase in temperature will accelerate corrosion rate;
- SANDVIK 2RE69 has higher mechanical strength than 316L types and has better corrosion resistance when compared with 316L or 317L.
- Stress corrosion cracking resistance is also better with 2RE69.

Saudi Arabia

Mr. I. Al Makanzi presented his paper on the following corrosion problems at the Saudi Arabian Fertilizer Company (SAFCO), ID/WG.303/6:

a) Corrosion in the urea reactor bottom: the repair of the unit was made by an overlay weld using Thermanit 19/15H having superior corrosion resistance to E-316L originally used;

b) Corrosion in MEA heat exchanger used for desulphurization of NG where SAFCO faced corrosion problem in the dome side of MEA heat exchanger. The following suggestions were made by the participants:

i) Use of a purifier should be adopted to reduce the iron content in the MEA solution according to Mr. Sayeed of Bangladesh:

ii) Mr. Berner of SANDVIK pointed out that there are some good publications on corrosion in MEA exchanger and way of avoiding such corrosion. He volunteered to make these publications available to Mr. Makanzi of SAFCO;

iii) Mr. Nabi of Kuwait suggested that molar ratio should be kept low to avoid corrosion;

iv) Mr. Srinivasan said that in India he also faced vapour corrosion. He suggested clading (plain 18/8) solves the problem;

v) Following references to MEA corrosion were given:

a. Hydrocarbon processing, August 1971, pp.109-111 "Stop MEA-CO_2 Unit Corrosion";

b. Hydrocarbon Processing, September 1973, pp.151-155 "Gas Plant Start Up Problems".

Kuwait

Mr. B.H. Abdel Nabi presented his paper, ID/WG.303/7, on corrosion problems experienced in ammonia and urea plants. In his paper he highlighted the corrosion problems connected with

a) Sulphur removal;
b) Natural gas steam reforming;
c) CO conversion;
d) CO_2 removal and recovery system;
e) Synthesis gas compression and ammonia synthesis;
f) Cooling Systems.

During the discussion that followed the experience on the use of 316LN and 26/1 for handling urea/NH_3 carbamate solutions with reciprocating pumps were highlighted. The 316LN SS has been used in high pressure pipes successfully in connexion with urea solutions. The use of ferritic material(26Cr/1 Mo) attracted interest 8 - 10 years ago. It resulted,however, in intergranular corrosion and brittleness after welding and has, therefore,not been used to great extent.

Sulphuric Acid, Phosporic Acid, TSP, Nitric Acid and NPK Plants

Sulphuric Acid Plants

Experience from a sulphuric acid plant in Tunisia was summarized by Mr. Bencharrada:

a) For the cascade cooler fabricated of iron, pitting corrosion occurred on the inlet and outlet parts. The temperature of the acid was 100°C at the inlet (bottom) and 70°C at the outlet (top). The high temperature was explained by the fact that the inlet and outlet parts were plastic coated and thus only partially cooled.

Among the proposed solutions of the problem, more effective plastic coating and stainless steel were mentioned. If stainless steel is to be used, the whole cooler should be exchanged and not only the corroded parts, otherwise problems with galvanic corrosion of the carbon steel is expected. Since the temperature is rather high, plastic coatings of PVC or similar material were not recommended.

b) For the absorption acid of 100°C stainless steel type 20Cr/25Ni/4.5Mo/1.5Cu (UB 6), corresponding to SANDVIK 2RK65, had been put in to replace cast iron on which corrosion problems had occurred. The stainless steel had been in service for one year now without failing.

c) Corrosion problems at the tube plate inlet of SO_2 of 430°C on tubes of SiCrAl were mentioned.

d) In the absorption column at the upper part for condensation of sulphuric acid 316 type of steel had been replaced by UB 6 because of the very high corrosion rate.

Another question was raised about corrosion problems in storage tanks for sulphuric acid. One of the answers was that if the liquid level could be varied frequently and continuously, there would be no corrosion problem. Also rubber lining was proposed.

Mr. Srinivasan pointed out the Si-Fe material (14.5 per cent Si) to be suitable for sulphuric acid.

Mr. Comarmond commented on the difference between the sulphuric acid of up to 40 per cent concentration and the "non water like" behaviour at higher concentrations. The activity of H^+ in the concentrated acid is difficult to evaluate.

A corrosion case in sulphuric acid production was mentioned.

In a double pipe heat exchanger (see figure 1), corrosion was experienced at the inlet.

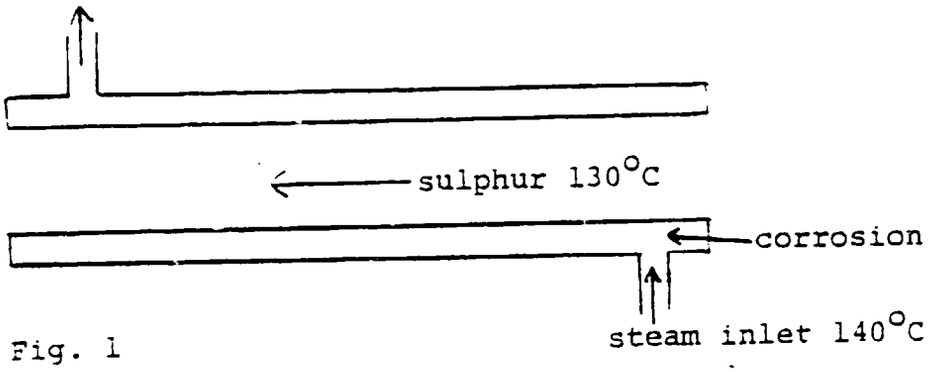

Fig. 1

Suggested solutions:

a) Change of the steam direction;

b) Change of the "nozzle" design.

Nitriding of 304 in rich synthesis gas (synthesis side) at 400-500°C was discussed. Which service life can be expected? As an answer it was claimed that alloy 800 has a very good resistance to nitriding at temperatures up to 550°C due to its high chromium and nickel contents. AISI 304 has a reasonable resistance to nitriding at 400°C in the order of 0.02 mm/year and is acceptable also at somewhat higher temperatures. Ferritic stainless steels have a higher nitriding rate than the austenitics.

Phosphoric Acid and TSP Plants

Mr. Österholm presented the paper "SANDVIK Sanicro 28 - a high alloy special steel for heat exchangers in phosphoric acid plants".

Questions were raised about the pumps. To that Mr. Keleti had the experience that at least alloy 20 type of stainless steel was necessary. However, pumps fabricated of URANUS B6 or HENRIOT HV9 have superior resistance against corrosion when handling phosphoric acid slurries. Fluorine scrubbers fan impellers were epoxy coated Hastelloy "C". They stood up for a limited time. Ferritic-austenitic stainless steels show long service lives when used in the pumps. In Israel the impellers of PVC were attacked by HCl. In Holland PVC agitators were used (the acid there held 1000 ppm Cl^-, to be compared with Jordan rock with 3000 ppm Cl^- in the process solution).

In phosphoric acid concentrator, it was pointed out that heat exchanger tubes made of Sanicro 28 have superior performance compared with earlier tested materials, e.g. Nionel (alloy 825).

The question was raised if there was any experience of Sanicro 28 in the tube reactor in TSP production. The answer was no, but judging by the properties of Sanicro 28 SANDVIK expects this alloy to be an economically very attractive alternative for instance to Hastelloy C.

The problem in handling HF from phosphoric acid reactors was mentioned. Hastelloy C was said to have a limited service life as fan blades in contact with SiF_4-gas. A high-chromium alloy was recommended, since chromium in the alloy very strongly decreases the corrosion rate in solutions containing F^-. Type 27Cr/31Ni/3.5Mo/1.5Cu will give an increased service life.

Hardfacing was mentioned as an alternative to solve erosion-corrosion problems. As suitable hardfacing alloys, stellite, Mn-alloyed C-steel and ferritic chromium steel were suggested.

Hardfacing with stellite has solved erosion-corrosion problems in spinning baths.

It was pointed out that really qualified welders were needed for hardfacing. Otherwise there is a risk for improper operation and low adherence of the hardfacing layer resulting in spalling of the layer.

It was mentioned that rubber lining of piping and tanks often was the simplest and cheapest solution of corrosion problems. There are, however, difficulties in estimating the service life.

Mauritius

Mr. G. Comarmond presented his paper on case history in a nitric acid plant, ID/WG.303/1: Corrosion problems encountered at Mauritius Chemical and Fertilizer Plant.

He described in his paper the failure due to corrosion of the tail gas reheater used in the high pressure ammonia oxidation process, causing cracking of the tube sheet made of 321 stainless steel (18/8), tail gas tempering heater, where 304L tubes have been replaced by SANDVIK 3RE60. In this connexion the author questioned whether SANDVIK 2RE10 would not have been a more appropriate replacement. Corrosion at the cooler condenser fabricated of SS type 430 was also reported and described as crevice corrosion in this very informative paper.

SANDVIK recommendations included certain tests to be made in the field and offered their services to evaluate the same.

It was pointed out by Mr. Keleti that in NPK-granulation there are abrasive conditions in the pumps. A frequently used material for casings and impellers in the USA the ferritic-austenitic Cd$_4$MCu (26Cr5Ni2Mo3Cu) in Germany 28/4 Mo and in UK British specification R-53 were used. Mr. Keleti promised to send Mr. Comarmond the relevant specifications. In general, ferritic-austenitic or hardenable ferritic stainless steels are used to solve abrasion problems. Comments were made on some problems in pumps, impellers, storage tanks in an ammonium nitrate plant. 316 impellers fail very fast, while plastic impellers give an improvement.

In a storage tank for NH_4NO_3 - slurry steam heated 316 heating coils pitted. Type 25Cr/22Ni/2.1Mo/N was recommended to solve this problem, since this grade has a better resistance to pitting.

A valve in AISI 304L is frequently corroded in contact with ammonium nitrate 140°C. Type 25/20 was recommended as a replacement.

A back pressure valve corrodes in a week in a slurry of NH_4NO_3, phosphoric acid and KCl. A change in design to a ball valve was recommended, also a change of materials to Duriron (14.5Si/Fe) or carborundum.

Type 20Cr/34Ni/2.5Mo/3Cu/Nb and duplex stainless steels (e.g. 22Cr/5.5Ni/3Mo/N) were also mentioned as alternative materials.

Construction Materials for Seawater Cooling

Mr. Mats Tynell, SANDVIK AB, presented his paper introducing the subject.

In connection with the presentation of his paper "Corrosion problems experienced in ammonia and urea plants" Mr. Abdul Nabi mentioned that in tests being run with Alloy 625 two tubes were plugged after only two months' service. The failure could be due to some fabrication defect,

but it was difficult to judge the true cause since the investigation was not finished. In any case the information was very surprising to the audience considering that Alloy 625 (61Ni/22Cr/9Mo/3Fe) has been known to be practically immune to seawater corrosion.

III. The Participants Evaluation

Sixteen participants and one observer from the developing countries completed the evaluation forms of UNIDO.

The general concensus of the opinions is as follows:

The programme of the Technical Consultation on Corrosion in Fertilizer Plants was appropriate and sufficient in concept, but the duration was too short. Ten days to two weeks would have been better for duration time allotted to carry out this programme.

Most of the participants considered the size of the group adequate and felt they integrated well into the group.

The majority of the participants felt that the practical aspects should be stressed and felt that more emphasis should be given to welding procedures of stainless steel. They felt that the theoretical part and the number of plant visits were adequate.

The coverage for individual studies was too little. The training material used was adequate.

The time allotted for professional exchange with the experts, fellow participants and organizing staff was sufficient.

The participants felt that they benefited from the exchange of information with the professional staff and other participants but to lesser extent from the factory staff.

The general opinion expressed on whether the programme was relevant to the situation in their countries was divided.

Majority of the participants recommended that the programme should be repeated in another developed country as they benefited from the meeting to a sufficient extent and this will be recognized in their home countries.

Suggestions and recommendations by participants are as follows:

1. More data and consideration should be given to the economic aspects on corrosion prevention.

2. Country papers presenting case studies should be distributed to participants at least one month before the Consultation meeting is convened to allow preparation for their contribution.

3. The practical side of the Consultation should be emphasized, particularly as far as welding procedures are concerned.

4. More emphasis should be given to fabrication of equipment, heat treatment, forming, cutting and inspection procedures.

5. Fertilizer producers should be invited to participate and present their own experiences in corrosion in their plants.

IV. Conclusions and Recommendations

Conclusions

There was a general agreement amongst the participants that

a) the programme provided for the Technical Consultation meeting was satisfactory;

b) they benefited from the programme and obtained valuable information on corrosion to take back to their home countries;

c) the time was too short to enter into sufficient detailed discussion on certain aspects of corrosion and how to prevent it;

d) the material aspects of corrosion were well covered in the various papers presented, but some practical aspects on how to prevent corrosion could have been dealt with in more detail.

Recomendations

There was a general agreement amongst the participants that

a) future consultation meetings on corrosion in fertilizer plants should be convened by UNIDO and that in order to cover the subject more fully at least ten days to two weeks should be allocated for this meeting;

b) in order to improve the programme, it was recommended that the economi. aspects on corrosion prevention should be increased for future program

c) an increased emphasis should be given to practical aspects of corrosion prevention and that such as welding procedures, equipment fabrication techniques, heat treatment, forming and inspection procedu

d) a future programme should also include experiences of fertilizer manufacturers;

e) country papers should be circulated a month before the next meeting to selected participants in order that they can make their appropriate contribution at the meeting.

ANNEX I

LIST OF PARTICIPANTS

Country	Name	Address
Bangladesh	CHOWDHURY, Foizul Haider	Chief Engineer of the Maintenance Department Urea Fertilizer Factory Ghorasal Dacca
	SAYEED, Mohammad	Additional Chief Operation Manager Urea Fertilizer Factory Ghorasal Dacca
China, People's Republic of	SUN, Weimin	Deputy Chief Engineer Chemical Industry Planning Institute Peking
	ZHONG, Yilie	Deputy Chief Engineer Chemical Industry Design and Engineering Institute Chengdu, Szechuan
Egypt, Arab Republic of	HAMZA, Mahmoud	Head of Inspection Department Abu Qir Fertilizer and Chemical Industry Alexandria
	OMAR, Rizk	Maintenance Manager Abu Qir Fertilizer and Chemical Industry Alexandria
India	SAIT, A. Ismail	Plant Engineer The Fertilizer and Chemicals Travancore Ltd., Cochin Division Ph.II P.O. Ambalamedu, Pin 682303
	SRINIVASAN, C.V.	Senior Inspection Engineer Madras Fertilizer Ltd., Madras 600068

Country	Name	Address
Indonesia	PRASETYANTO	Superintendent of Inspection Department P.T. Pusri Sei Selayur P.O. Box 084 Palembang
Kuwait	ABDUL NABI, Baha'a El-Din	Corrosion Inspector Petrochemical Industries Co. P.O. Box 9116 Ahmadi
Mauritius	COMARMOND, Germain	Process Engineer of the Technical Department Mauritius Chemical and Fertilizer Ind. P.O. Box 344 Port-Louis
Saudi Arabia	ALDOUS, Abdul-Mohsen	Saudi Basic Industries Corp., P.O. Box 5101 Riyadh
	AL-MAKANZI, Ibrahim	Maintenance Engineer SAFCO P.O. Box 553, Dammam
Syrian Arab Republic	RASLAN, Ghiath	Production Manager General Fertilizers Co. P.O. Box 280 Homs
	TURK, Ahmed	Project Engineer, Ammonia-urea General Fertilizers Co. P.O. Box 280 Homs
Tunisia	BENCHARRADA, Mohamed Khélifa	Technical Adviser on Appropriate Technology Head of Section S.I.A.P.E. Boîte Postal "S" Sfax

Observers

Name	Address
GANIM, M. Jasim	Industrial Development Centre for Arab States (IDCAS) 5 Rue Robespierre Tunis, Tunisia (telex COPMAG 12337)
LINDBLAD, Lars	Technical Adviser on Appropriate Technology Head of Section Swedish International Development Authority (SIDA) Birger Jarlsgatan 16 S 105 25 Stockholm Sweden
KAMEL, W.	Industrial Development Officer Non-Governmental Organizations and Business and Industrial Institutions Co-operation Section United Nations Industrial Development Organization (UNIDO) P.O. Box 400 A-1400 Vienna Austria
KELETI, Cornelius E.	Senior Industrial Development Officer Chemical Industries Section UNIDO P.O. Box 400 A-1400 Vienna, Austria

ANNEX II

TECHNICAL CONSULTATION ON CORROSION IN FERTILIZER PLANTS
Sandviken, Sweden, 27 - 31 August 1979

EVALUATION

Number of participants: 16 participants and 1 observer completing this form.

Host country: Sweden

Year: 1979

The following statistics emerge:

1. What is your opinion about the contents of the programme?

appropriate	15
not appropriate	2

If not appropriate, please state why:

2. What is your opinion about the level of the programme?

too high	2
sufficient	15
too low	

3. Is, in your opinion, the programme:

too specialized	
too broad (covering too many subjects)	6
correct in its concept	11

4. What is your opinion about the total duration of the programme?

much too short	3
too short	11
correct	2
too long	
much too long	

If too short or too long, what should have been the duration?

...2... weeks. (by eight participants)

5. Do you consider the size of the total group of participants:

too large [1]
adequate [13]
too small [3]

6. Give your opinion about the composition of the group of participants (home country as to educational level, profession, age, etc.). Were there too many under-qualified, or over-qualified participants. Did you personally feel integrated in the group or, if not, why?

7. What is your opinion about the general character of the programme. Should it, in your opinion be:

more practical [9]
more theoretical [4]
as it is [4]

8. How was, in your opinion a) the amount of practical training?

too much [ ]
adequate [8]
too little [9]

b) the amount of theoretical studies (lectures):

too many [4]
adequate [12]
too few [1]

c) the number of study visits:

too many [ ]
adequate [11]
too few [5]

Please state your suggestion for changes, if any:

9. What is your opinion about the time allotted for individual studies?

too much [ ]
adequate [6]
too little [11]

10. What is your opinion about training material used?

Majority says "adequate". Three participants say "inadequate".

11. Did you have sufficient time for a professional exchange of views

with instructors:	yes	16
	no	1
with fellow participants:	yes	15
	no	2
with staff of the factories:	yes	10
	no	4

12. Did you benefit from that exchange

with instructors:	much	10
	little	4
with fellow participants:	much	9
	little	7
with staff of the factories:	much	5
	little	10

13. Did you feel that you could influence the programme content?

much	2
somewhat	9
little	4
not at all	-

14. Did you find the programme as conducted relevant to the situation in your home country:

to some extent only	6
to a sufficient extent	6
to a great extent	2

15. Do you think this programme should be repeated?

yes	14
no	2

16. If yes, do you think it should be held

in the same country and place	2
in the same country but another place	1
in another developed country	9
in a developing country	2

17. Do you feel that your participation in this programme has benefitted you professionally?

to a very small extent	1
to some extent	6
to a sufficient extent	7
to a high extent	2
to a very great extent	-

18. Do you think that the qualifications you may have acquired will be recognised in your home country?

yes	13
no	2

19. Other suggestions:

ANNEX III

List of Background Papers provided by SANDVIK AB and Swedish Corrosion Institute(SCI)

	TITLE	AUTHOR(s)
1.	Quality Assurance - a Must in the Production of Dependable Construction Materials	R. Kiessling
2.	Current Types of Stainless Steels, Nickel Alloys, Titanium, Tantalum and Zirconium	S. Bernhardsson
3.	Chemical Analysis - Service to Production Control and Quality Assurance	R. Karlsson
4.	Quantitative Metallography in Production Control - especially referring to Non-metallic Inclusions in Steel	B. Lärk
5.	Mechanical Properties and Testing Methods	N.-G. Persson
6.	Various Types of Corrosion	S. Bernhardsson
7.	Standard Specifications for Stainless Tube and Sheet	R. Österholm
8.	Some Aspects of Manufacture of Apparatus in Special Materials	H. Gyllensten
9.	Stainless Pipe Components, Introduction	L.M. Larsson T. Westberg
10.	Welding Methods	B. Lundqvist
11.	Expanding and Welding of Tubes into Tube-sheets	B. Lundqvist
12.	Welding Meterials, Welding Metallurgy	B. Lundqvist
13.	Ammonia	B. Larsson
14.	Nitric Acid	U. Lundell
15.	Urea	U. Lundell
16.	Sulphuric Acid	S. Bernhardsson
17.	Inorganic Fertilizers	U. Lundell
18.	Phosphoric Acid	R. Österholm
19.	Construction Materials for Seawater Cooling	R. Mellström

	TITLE	AUTHOR(s)
20.	Presentation of SCI	E. Mattson
21.	Activities at SCI in the Field of Information and Education. Film "Corrosion Prevention by Design"	G. Svendenius
22.	Atmospheric Corrosion	V. Kucera
23.	Anti-rust Painting	L. Igetoft
24.	Corrosion Inhibitors	A. Thorén

ANNEX IV

List of Papers provided by UNIDO as Background Information

SYMBOL NO.	TITLE	AUTHOR
ID/WG.221/8	Stress Corrosion Cracking in Ammonia Plants	Mervyn E.D. Turner Imperial Chemical Industries Limited Agricultural Division Billingham, UK
ID/WG.221/22	Corrosion Problem in Air Separation Plant	A.S. Chatha Fertilizer Corporation of India (FCI) Gorakhpur, India
ID/WG.221/23	Corrosion Control in Ammonia Plants	V.S. Pillai Zuari Agro Chemicals Ltd., Zuarinagar, India
ID/WG.221/30 (ID/171)	Report on the UNIDO/FAO Interregional Meeting on Safety in the Design and Operation of Ammonia Plants	UNIDO Secretariat

ANNEX V

LIST OF PAPERS (PARTICIPANTS)

SYMBOL NO.	TITLE	AUTHOR(S)
ID/WG.303/1	Country Paper by Mauritius Corrosion Problems encountered at the Mauritius Chemical and Fertilizer Industry	G. Comarmond The Mauritius Chemical and Fertilizer Industry Ltd., Port Louis, Mauritius
ID/WG.303/2	Country Paper from Indonesia The Corrosion of CO_2 Stripper Gas Reboiler in P.T. Pupuk Sriwidjaja, Indonesia	U. Sumitro P.T. Pupuk Sriwidjaja Palembang, Indonesia
ID/WG.303/3	Country Paper from India Stress Corrosion Failures in Reformer Furnace Components	C.V. Srinivasan Madras Fertilizers Ltd. Madras, India
ID/WG.303/4	Country Paper from the People's Republic of China A Presentation of Typical Equipment Corrosion Phenomenon in Large Scale Ammonia Plants	Yilie, Zhong Chemical Industry Design and Engineering Institute Szechuan, and Weimin, Sun Chemical Industry Planning Institute Peking, China
ID/WG.303/5	Country Paper from Bangladesh Urea Fertilizer Factory, Ghorasal, Dacca, Bangladesh, 660 mt/d Natural Gas based Ammonia Plant	M.D. Sayeed Urea Fertilizer Factory Ghorasal, Dacca, Bangladesh
ID/WG.303/6	Country Paper from Saudi Arabia Special Corrosion Problem and the Repair at SAFCO	I. Al-Makanzi Saudi-Arabian Fertilizer Company, SAFCO Dammam, Saudi Arabia
ID/WG.303/7	Country Paper from Kuwait Corrosion Problems experienced in Ammonia and Urea Plants	B.H. Abdel Nabi Petrochemical Industries Co., Ahmadi Kuwait
ID/WG.303/8	REPORT	UNIDO Secretariat