Operating practices

This condensed survey contains highlights obtained from 63 Air and Ammonia Plant operators and designers. Answers were received from about 60% of the U.S. operators.

The detailed 38-page survey was prepared by a subcommittee with the following members: Peter S. Hepp, Chm., Sun Oil Co.; Norton Walton, SunOlin Chemical (previously with Atlantic Refining); R. F. Bollen, Dow Chemical of Canada; R. W. Rotzler, Monsanto Chemical. The listing includes numbers in parentheses after each statement. These refer to the total number of actual answers, but do not include those who had no reply to the specific question.

Ammonia Loading:

A. 57% use hose for ammonia loading and 21% use both hose and pipe with swivel joints. (48)
B. 60% use stainless steel braided or reinforced hose, and 40% use rubber hose. (47)
C. 49% test at an average of 5 months. (45)
Of those who used rubber hose, 67% tested hydrostatically at regular intervals. Of those who used stainless steel reinforced hose, 60% did *not* hydrostatically test at regular intervals.
D. 79% of those who test hydrostatically tested at an average of 350 lb./sq. in. (29)
E. 26% discarded hose at an average of 11 months. (46) The remainder had no set schedule.
F. 40% did not ground cars and trucks when loading, and 58% did. (48)

Hydrostatic Testing:

A. 52% hydrostatically test sub-zero equipment. (46) 33% of the 52% test this equipment at an average of 5 years. (24)
B. 56% hydrostatically test syn loop vessels. (43) 50% of the 56% test the vessels at an average of 5 years. (24)
C. 63% hydrostatically tested compressor suction and discharge bottles and interstage separators. (51) 29% tested at an average of 5 years. (31)
D. 54% hydrostatically tested other vessels such as caustic towers, driers, etc. (52) 37% of the 54% tested at an average of 5 years. (27)
E. 53% test pneumatically. (53) 67% of the 53% test at an average of 110% of design. (27) 22% tested with air, 41% with N_2, and 26% with both. (27)

Temperature Limits for Carbon Steel:

A. 84% normally subject carbon steel to an average temperature of −6°F. (53)
B. 56% have *no specifications* for carbon steel in low temperature service, and 28% use one of the following specifications: aluminum or silicon killed ASTM-A-300 C1.1 ASTM-Sec. 8, ASTM—A106B, A-212 or A-201. (50)
C. 75% of the companies queried take precautions to protect piping leaving the cold box which, during upsets, may be subjected to abnormally low temperatures. Of those, 41% use copper or stainless piping as precautionary measures, and 17% have low temperature alarms or cut offs. (36)

Compressors:

A. 64% have tail rods; (56) of those, 42% use tail rod catchers. (48)
B. Company response indicating specifications for purchasing and periodically testing compressor piston rods, (53)

Specifications	Number of Companies	Per cent
Mfg's. specs.	13	24
Magnaflux	9	17
X-ray or radiograph	3	6
Ultrasonic inspection	5	9
Die check or whitewash	5	9
Straightness	2	4
Specify hardness of new rods	3	6
Use SAE 4140 steel	2	4
Miscellaneous	3	6

Miscellaneous:

A. How do you prepare spent catalyst for safe removal?

Ammonia Synthesis Catalyst:		
Purge with N_2	8	29 %
Controlled oxidation	13	46 %
Cool and dump	2	7 %
Cooled, N_2 blanketed, and dumped into closed container	2	7 %
Cooled, N_2 blanketed, and dumped into water	3	11 %
	28	100 %

Deoxo Catalyst:		
Purge with N_2	3	75 %
Submerge in water	1	25 %
	4	100 %

Shift Catalyst:		
Slow, controlled oxidation	14	73 %
Cool with steam inert gas	3	16 %
Dump into water or flood with water	2	11 %
	19	100 %

Reforming Catalyst:		
Slow controlled oxidation	8	73 %
Cool and dump	3	27 %
	11	100 %

Methanator Catalyst:	
Oxidize	1

Other:	
Oxidize all catalyst before removal	8

B. 22% protect nickel catalyst from the formation of nickel carbonyl by steam purging, 26% by N_2 purging, 17% purge by steam followed by air, and 17% use CO free gas. (23)
C. 79% purge the air out of NH_3 equipment before introducing NH_3. (48)
79% use N_2 for purge. (38)
D. 92% will not use mercury containing instruments on NH_3 systems.

Air Plants, Inlet Air:

A. 63% monitor for impurities. (40)
B. Of those who monitor 80% monitor after the compressors. (25) 28% monitor for impurities continuously, and 52% monitor intermittently. (25) 88%

monitor for hydrocarbons, 28% monitor for oxides of nitrogen, and 44% monitor for C_2H_2. (40)

C. 13% have more than one inlet, depending on wind direction. (38)

D. 7% employ catalyst beds to oxidize hydrocarbons in the inlet air. (40)

E. 87% used reciprocating air compressors, 38% discharged at 50 to 350 lb./sq. in., 33% at 350 to 700 lb./sq. in. and 27% at 2500 to 3000 lb./sq. in. (40)

F. 3% use non-lubricated rings as a lubricant in air compressors, 63% use hydrocarbon oils, and 34% use synthetic lubricants. (38)

G. The average maximum discharge temperature permitted on feed air compressors is 315°F. The committee found no apparent correlation between discharge pressure or oil type to the maximum temperature permitted.

Silica Gel Hydrocarbon Adsorbers in Air Plants:

A. 93% have silica gel filters in low pressure tower feed, 15% feed air to expanders, and 17% have the filters in the low pressure tower reboiler circuit. (53)

B. The average space velocities for filters in the low pressure tower feed is 47 lb. of air/lb. of gel/hr.

C. The average time between regenerations of low pressure tower feed filters is 136 hours. (35) 61% regenerate with N_2, and 37% regenerate with air. (41)

D. During regeneration, feed filters are heated to an average temperature of 195°F.

E. The average time used to hold the gel at the average temperature is 6 hours. (37)

F. 54% discarded gel at an average of 22 months. (37)

G. Companies' criteria for discarding gel (47)

Criteria	Number of companies	Per cent
Color	18	53
Efficiency of adsorption	8	23
Oil contamination	4	12
Dusting; high pressure drop	8	23
At a set time; at shutdown	4	12

Air Plant Reboiler Monitoring:

A. 40% of the air plants remove the product O_2 as a vapor. Of these, 41% use auxiliary vaporizers. 81% of the vapor plants withdraw a liquid blowdown amounting to an average of 2% of the feed air.

B. 47% remove the product O_2 as a liquid. 16% of these use auxiliary vaporizers.

C. 18% continuously analyze for total hydrocarbons, oxidized to CO_2, on product O_2 or reboiler or vaporizer. 40% analyze continuously for product purities, O_2 in N_2 and/or N_2 in O_2. (23)

D. Acetylene testing.

1. 90% analyze intermittently for C_2H_2.
2. 90% test on a regular schedule, and 75% test every day, or more frequently. (37)
3. 75% of the tests are located in the reboiler or O_2 product, 17% in the vaporizer, and 17% in the absorber. (39)
4. 55% use Ilosvay for testing, 11% use Colorimetric, 8% use chromatographs. (31)

E. Hydrocarbon testing.

1. 57% intermittently test for hydrocarbons. (23)

2. 52% test every two days or more often.
3. 56% of the tests are in the reboiler or O_2 product, 35% are in the vaporizer or separator, and 22% are in the absorber. (26)
4. 13% use a chromatograph for the tests, 22% use infra-red, 16% use flame ionization, and 27% use miscellaneous methods. (18)

F. Nitrogen oxide testing.

1. 20% test intermittently for nitrogen oxides. (8)

G. Limits for Shutting Down.

1. 80% have definite shutdown limits in reboilers for C_2H_2. (37)
   a. The average shutdown limit for C_2H_2 in reboilers and vaporizers is 1.4 ppm. (33)
2. 32% have definite shutdown limits in reboilers for hydrocarbons. (37)
   a. The average shutdown limit for hydrocarbon in reboilers is 290 ppm. (14)
3. 12% have definite shutdown limits in reboilers for nitrogen oxides. (37)
   a. The average reboiler shutdown limit for oxides of nitrogen is 0.1 ppm. (37)
4. 0.09 ppm is the normal level of C_2H_2 contaminants in reboiler. (30) 43 ppm is the average hydrocarbon contamination in reboiler. (21)
5. 65% of air plant operators hold liquid an average of 19 hr. in the air plant during an emergency shutdown. (38) 12% as long as contaminants do not exceed maximum limits.

Air Box Insulation:

A. 73% use mineral wool or rock wool insulation in the air plant. (29)

B. 55% specified an average of 0.15% oil maximum for air box insulations for safety reasons. (40)

Defrost and Solvent Wash of Air and H_2 Boxes:

A. For safety reasons, 75% defrost air boxes at an average of 12 months. (36)

B. 50% solvent wash the air box at an average of 2 years. (34) Trichloroethylene and carbon tetrachloride are the most frequently used solvents.

Handling Compressed Oxygen:

A. What type of compressor do you use to handle oxygen? (20)

Liquid pumps	45%
Centrifugal	15%
Piston compressors	60%

B. What materials of construction are used for piping? (18)

Stainless steel	39%
Copper	33%
Carbon steel	17%
Aluminum	6%
Carbon with stainless steel section	22%
Ex Hy. Red brass	28%

C. What type valves do you use? (16)

Non-ferrous	9%
Stainless	17%
Metal seated brass globe	17%
Miscellaneous	39%

D. What type of filters do you have ahead of the compressor? (15)

Wire screen	30%
None	20%
Miscellaneous	25%

Hydrogen Box Purging:

A. What is the approximate volume of your H_2 box?

B. How much N_2 purge do you use during normal operation?

Volume cu. ft.	Purge, cu. ft./hr. unless noted	Turnover, hr.
1000 to 1900	210	
2000	120	17.0
2750	0	0
3450	600	6
3500	No answer	..
3200 to 6400	210	..
4000	1500	2.7
4500	3000	1.5
5240	1/16 in. H_2O press.	..
5700	6 in. H_2O press.	..
5700	No answer	..
6200	¼ in. H_2O press.	..
6700	1900	3.5
8000	2000	4
12,000	15,000	0.8
16,450	5000	3.3
17,400	6000	3
17,600	24,000	0.7
24,000	420	57
35,000	8400	4
No ans. −1	Average of 52% (excluding 57)	4

C. 53% test the atmosphere in the hydrogen box for O_2 an average of once every week. (21) 62% test on a routine basis for flammable materials an average of once every week.

D. What limits are placed on these materials?

No fixed limits	24%
Non-explosive	24%
H_2 1%; 4%; lower explosive limit	14%
CO–10 ppm	5%
O_2–0%; 2%; 4%; 5%; 5%	29%
No answer	24%
(Some gave more than one limit)	120%

Note: 29% set a maximum O_2 content of 3% average.

E. Will you make any repairs in the hydrogen box while running? (20)

No	67%
No welding	14%
Limited repair	5%
Yes	9%

F. When shutdown, will you do hot work in H_2 box without emptying insulation (in a cavity)? (20)

Yes	43%
No	52%

Note: There was no apparent correlation between the source of feed gas and the answers to question E and F.

G. What type of insulation do you have in H_2 box? (21)

Rockwool or Mineral wool	81%

H. Do you purge the air out of process equipment before introducing flammable materials? (21)

Yes	100%

I. Purging process equipment: What do you use for purge? (21)

N_2	100%