SAFETY AND THE LARGE AMMONIA PLANT

One potential hazard lurks in the rush job to get plants built during recent years; thorough inspections are needed to eliminate the potential risk

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Safety is, from my understanding, simply the protection of human life, limb and health. I think sometimes the protection of the continuity of production and equipment performance get confused with true safety. They are certainly interrelated because failures of equipment frequently lead to safety hazards. But safety, and I think we should not lose sight of the fundamental facts, is protection of human life, limb and health. So that means the fundamental difference between the consideration of safety and the consideration of continuity of production and equipment performance is, that with regard to safety, we don't play odds, nor do we take calculated risks.

Both of these things are perfectly permissible practices in the design of plants, based on economic consideration. They do, of course, affect safety and when such calculated risks or odds are incorported in plant designs, the safety aspects should certainly be a part of the overall consideration.

The major safety hazards

I have jotted down what, in my opinion, are the major safety hazards in ammonia plants. This list, not by intent but by coincidence, I believe, pretty well summarizes items that have been the topic of discussion already at this meeting or will be topics of discussion before the meeting is over.

These include handling of toxic and inflammable gases, also handling inflammable gases at high temperatures. In many parts of an ammonia plant the confined gas is above the ignition temperature if mixed with air, which means immediately on exposure to air a fire results. Also, the inflammable gases are frequently confined in large vessels, which means the stored energy therein is large. A failure or rupture can result in considerable damage and loss of life.

Another safety hazard which is well known and has been discussed is corrosion and erosion. All of you know and are aware of the results of these two hazards.

The fourth is metal deterioration. This occurs in one form or another from one end of an ammonia plant to the other. Such phrases as a sigma phase, carbon precipitation, nitriding, hydrogen attack, caustic embrittlement, vibration fatigue, and low temperature effects are familiar. I am sure all of you at various ammonia plants have seen the results of these to some degree or another.

The large volume storage of ammonia is a safety hazard, in my opinion, and I think by the amount of consideration and discussion it has drawn, this is generally recognized.

Noise as a hazard

Noise levels may be safety hazards. It is just recently that much importance and stress has been put on this hazard. It is becoming more and more recognized, more and more states and communities are drawing up definite specifications for acceptable noise levels.

One reason, probably, why noise levels have come into more consideration with regards to safety is that the old ammonia plants with their gas engines and reciprocating compressors were what you might call grumblers. Low frequency sounds can be tolerated much better than high frequency sounds. And from experience I know the new ammonia plants might be called screechers. Most of the noise is of a much higher frequency.

Another hazard is the plant effluents, both to the atmosphere and to ground streams. Again this is receiving much more attention than in previous years because of many reasons, such as the location of plants in more populated areas, and the growth of population around the plant. I expect it is also attributed to the growing scarcity of water. Effort to recover water also means the recovery of certain deleterious materials in the water which, in the end result, is contaminated water. The contaminants must be kept separated from the effluent.

Last but not least, of course, are human failures, such as ignorance, lack of training, laziness, overwork, poor housekeeping, lack of coordination, etc.

All of these hazards are to be found in either large or small ammonia plants. The human failures are common in both and will always be with us.

What is a large plant?

Since this discussion is safety as related to Large Ammonia Plants, I suppose that means defining what is a large ammonia plant. The terms large and small are indefinite terms. A few years ago it could be said that small ammonia plants were maybe 50 tons/day production, a large one 300 tons/ day production.

For the purpose of this discussion I would define a large ammonia plant as being one that uses a centrifugal compressor for syn gas, and or uses single train equipment for 600 tons per day production or greater. For example, I don't think for the purposes of this discussion it could be said that a 1000 ton/ day plant is a large plant if it were made up of a multiplicity of 200 tons/day trains simply tied together.

So with that definition, what are the new safety hazards that have been introduced by large ammonia plants? The centrifugal compressors being used introduce no new hazards, per se, in my opinion. Centrifugal compressors for other applications have been used in ammonia plants for years. There is one area, however, in which these machines may contribute to the safety hazard of the plant. There is no backlog of performance experience for machines of this type and this application. They have been used in similar applications but, nevertheless, any time equipment is used without a long backlog of experience-debugging, etc., there is a certain hazard involved.

Hi-temp, hi-pressure steam

These large ammonia plants all, in various ways, use high temperature, high pressure steam. Again, high pressure is indefinite, but high pressure I would say in this case means pressures in excess of 900 lbs. Generally speaking, they range 900 to 1,500 lbs. The old, or smaller plants were much simpler. The majority were comprised of, more or less, separate sections which could be started, each one individually, and the gas therefrom vented or passed on in the next section, which made it a much simpler plant.

The large ammonia plants, in order to increase their efficiency, and I think that is their major premise, squeeze all the energy possible out of the steam and waste process heat. This leads to a complicated ammonia plant design. Each of the various sections of the plant - gas generation, CO conversion, purification, etc., are all much more interrelated in order to conserve energy. Of course, this introduces hazards.

I think also hazards are introduced merely by the fact that we are using single train equipment for 600 tons or better. That means it is large equipment. When piping gets large, the wall thicknesses are increased, as well as diameters, which means of course the piping is much less flexible. It is not so much the temperatures and pressures that count; it is the stresses developed.

The same applies to the vessels of course. The diameters are up, the wall thicknesses are up, the whole plant becomes more stiff, more rigid, and it becomes more difficult to safely incorporate into the designs all the necessary flexibilities.

Also, larger equipment is more likely to be damaged in shipment because equipment the size we are talking about in plants of this size certainly stretches the capability of all the carriers, who may on their part really exceed their limitations, increasing the likelihood of shipping damage.

Another item I have here generally relates back to no backlog or background of actual performance experience on much of the equipment. There are constantly being developed new techniques, and new materials available. Many of these are being introduced into the plants. They sound good on paper but there is no real history of proven experience for the material nor for the particular design.

Boom building conditions bad

Another safety hazard which may be somewhat controversial, but at least it has been my observation, is the sign of the times. These plants came along at a time of booming economy. They themselves were part of the boom. This meant that manufacturers of all kinds of equipment and machinery soon became overloaded. There was a general rush to get these plants designed and built, all of which has lead to - my observation of it, at least - poor quality control and substitution of materials. Inadvertent substitutions which really is part of quality control are more numerous than I have ever experienced before in the 20 years or so that I have been in business. These will ultimately, if not caught, introduce safety hazards in the plant. The remedy, of course, is for everyone engaged in the design, suppl of equipment, and operation of these plants to recognize the signs of the times: the overloaded shop conditions and the great pressures to get such plants into operation. Take time out for thorough inspections.