The Effect of The Energy Crisis on Ammonia Producers

If decisive and drastic action is not taken by federal authorities quickly, what is now a crisis could turn into a disaster by the winter of 1973-74.

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For some time now, the United States has been consuming its potential energy supplies at a greater rate than new sources of energy are being discovered. Because of this continuing deficit utilization of energy, this country now faces a severe and immedite shortage of all forms of energy derived from petroleum.

The energy source that most concerns ammonia producers is natural gas because most of the ammonia produced in the United States is based on reforming natural gas to produce the hydrogen-nitrogen mix required for ammonia synthesis. Natural gas supplies one-third of the total U.S. energy requirements and is already unable to meet current demands. Unfortunately, the public is unaware of the seriousness of the gas shortage and, therefore, has brought little organized pressure upon the government demanding that steps be taken to ameliorate the situation. If decisive and drastic action is not taken by the federal authorites quickly, what is now a crisis could turn into a disaster by the winter of 1973-74.

Because of this absolute shortage of natural gas, petrochemical manufacturers - more especially, ammonia manufacturers - have started to experience increasing curtailments and interruptions by the gas suppliers. Our company is involved in both sides of the problem. On one hand, the company produces large quantities of natural gas in the Gulf of Mexico, offshore Louisiana, and on the other, buys large quantities of natural gas in New York State to supply its synthetic anhydrous ammonia plant, located in Olean, N.Y. Because of this involvement with both production and use of natural gas, it was decided to attempt to determine the long-range effect of the worsening gas situation on ammonia manufacturers in general.

Natural Gas Once a Nuisance

So that we may better appreciate the effect of natural gas supplies on U.S. synthetic ammonia manufacturers, it would be well to analyze the historic developments that determined the economic feasability of using natural gas as a starting point for ammonia in this country. In 1965, while 40% of the world's synthetic ammonia was produced from coal, 81% of that produced in the U.S. was from steam reforming of natural gas.

In the early days of the U.S. petroleum industry, natural gas was actually a nuisance to oil producers and was often burned in flares merely as a way of disposing of it. Some of it was sold as fuel to fire boilers in the areas immediately adjacement to oil fields. As late as the days of the Smackover boom in southern Arkansas, gas was being sold at such a low price that people were expanding it directly in their steam engine, rather than bothering to burn it and generate steam.

New Industries Developed

Because of the availability of such vast quantities of low-cost energy, new industries developed, utilizing natural gas as either their energy source or their raw material. Concurrently, with the expansion of the industrial and chemical uses of natural gas, the domestic use of gas sprang up, and gradually, intercontinental pipelines were built and natural gas took over the market of manufactured gas in some areas, and in others, new distribution systems were built to use this clean, convenient and low-cost fuel in homes.

By 1930, natural gas production had developed as a significant arm of the petroleum industry and with the demand going up, natural gas was sought by itself, thus adding a new cost to the production of gas, that cost being exploration. As the petroleum industries attempted to recover this cost of exploration, the federal government stepped in and in 1938 the Federal Power Commission was created. The F.P.C. was given control over the distribution and pricing of interstate natural gas, and by 1954, the Commission had control of wellhead prices of gas going into interstate commerce. The theory behind the creation of the Federal Power Commission was not without merit. Viewing the large domestic distribution systems that had developed around the country, the government felt compelled to offer some protection to the householder who

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had converted his home to gas from some other less desirable fuel. Because of this control, natural gas prices have been kept artificially low. Therefore, the synthetic anhydrous ammonia industry that developed in the United States is based, for the most part, on synthesis gas produced by steam reforming of natural gas.

The price for this gas, although unrealistically low on B.t.u. basis, was still enough to support a certain amount of on-shore exploration for new gas. However, as the new discoveries of gas decreased, the petroleum industries began exploring for gas off-shore, particularly in the Gulf of Mexico. The cost of exploring and developing gas wells in deep water is obviously much greater than doing the same on land. So, with the gas price artificially fixed, it became less and less profitable for the oil companies to attempt to develop off-shore fields. Because of this disparity between the cost of finding and producing gas, and the price at which it can be sold in interstate commerce, the oil industry finds itself with little incentive to aggressively explore the deeper and more environmentally hostile off-shore areas. Therefore, we are seeing an immediate shortage of gas developed. It has now become necessary to ration the gas to the consumers according to the government's interpretation of who is most deserving. We feel that most people in the petrochemical business agree that burning natural gas to heat homes and to generate electricity certainly does not represent the highest and best use of this valuable hydrocarbon building block. Unfortunately, however, the government does not share this feeling, believing that the householder should have first call on any available gas with industry getting what's left, if any. We will attempt to show that, industry is, in fact, being subjected to ever increasing curtailments and interruptions of natural gas.

Questionaire

In order to better determine the experience of ammonia manufacturers to date, a questionaire, consisting of nine direct questions and one request for general comments on the energy crisis, was sent to all the manufacturers we could find. The questions were concerned with plant capacity, gas consumption, type of gas supply contract, cost of gas, number of days of gas interruption in the three preceding heating seasons, what the various plants do if they are interrupted, do they anticipate a continued worsening of the situation, and if so, what provisions are being made to cope with the gas shortage. Probably, the most significant thing that was learned from the survey is that there is great concern in the ammonia industry about the availability of natural gas. This was evident by the fact that over 60% of the questionaires were returned. These respondents represented 50% of the annual ammonia production in the United States as listed in the June 5, 1972 issue of *Chemical and Engineering News.* We consider this to be a much higher response than was to be expected from a form letter that was sent to an entire industry.

The questions on the form regarding capacity and gas consumption were asked in order to establish the percentage of American ammonia manufacturing capacity represented by the respondents, and to establish the amount of gas being consumed by the U.S. ammonia industry. The respondents to the questionaire represent an annual ammonia production of 6,859,000 tons and the average gas consumed per ton of ammonia was 36.8 thousand std. cu.ft. That means that half of the ammonia industry is consuming 266 billion std.cu.ft./hr. of natural gas. If the other half of the industry has the same pattern of gas consumption, then the U.S. ammonia industry is using 2.6% of the 1970 total gas production of the United States.

The answers to the questions concerning the type of gas contract indicated that 41.6% of the gas contracts are interruptible, and 58.4% are firm. However, there were a few cases where even producers on firm contracts were curtailed during the last heating season. 64.8% of the gas reported was interstate, with 35.2% being intrastate.

71.4% of the respondents stated that their gas contracts provided for escalation of the gas price. These escalation procedures varied in detail, but essentially, they were all based upon the cost of gas to the pipeline company from whom the ammonia manufacturers are buying their gas. The cost of the gas reported varied between 20- and 48.1c/million B.t.u.'s, with a weighted average cost of 37.6c/million B.t.u.'s

In order to encourage as large a participation in the survey as possible, the ammonia manufacturers were given the option of remaining anonymous and most of them chose to do so, so it was difficult to infer any geographical pattern of gas interruptions from the answers given by the respondents. It was apparent, however, that the number of days of interruption faced by the industry is increasing year by year. The respondents stated that in 1969, they had suffered a total of 326 days interruption, while in 1970, they suffered 412 days of interruption, an increase of 26.4%. In 1971, they suffered a total of 527 days, an increase over 1970 of 28.5%. The increase from 1970 to 1971 would have been much worse had the northeast not experienced such a mild winter.

Critical Nature of Shortage

Even though the last heating season in the northeast was mild, there was an incident in the middle of winter that pointed up the critical nature of the gas shortage. There was a failure of one pipeline system bringing gas on-shore from the Gulf of Mexico which cut off a portion of one of the long line pipeline company's gas supply. The effect of this disruption of service was not felt in the northeast; however, had the pipeline repairs taken only three days longer, a large section of the northeast would have had to have been curtailed, which means the industrial customers would have been completely cut off. It can be seen from this that the problem in the northeast is not one of limited pipeline capacity, but rather that of an absolute shortage of natural gas at the wellheads.

While 74% of the respondents to the questionaire stated that they expect the gas situation to worsen, only one-third are making provisions for the use of alternate hydrocarbons. However, the one-third stating they were making such provisions represented approximately 59% of

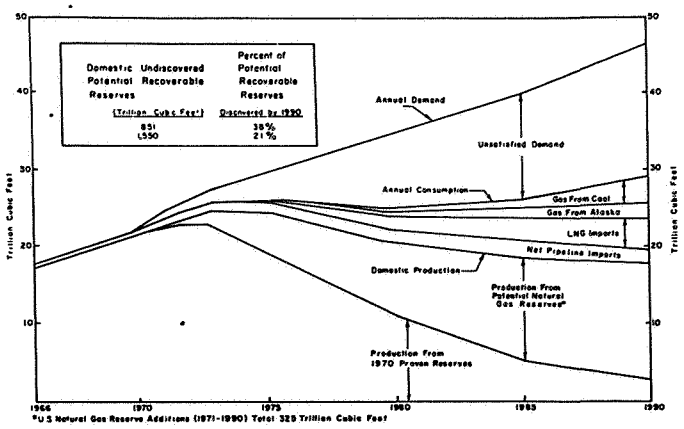

Figure 1. U.S. gas supply-demand balance (contiguous 48 states).

the ammonia production reported. This indicates that the larger plants are taking positive steps to substitute other hydrocarbons at various places at the plants, while the smaller manufacturers do not appear to be doing so. This is probably because the smaller plants already suffer an economic disadvantage due to size.

All of the respondents that said they were substituting or making provisions for substitution were doing so with fuel some place in the plant, rather than substituting raw materials. The most common substitution reported was that of using #2 fuel in the primary reformer furnace. From the results of this survey and discussion with people in the gas industry, it is evident that interruptions of the gas supply to all industries is going to increase in the next few years and this is going to happen all over the country, and not just in the northeast section of the United States.

Figure 1 was taken from a Federal Power Commission publication "(National Gas Supply and Demand, 1970-1980)" issued in February 1972. It can be seen from this graph that production of gas in the United States will peak in 1975 and decline thereafter. And, to make matters worse, the demand for natural gas cannot be fully met after 1970. It's probable that the intra-state gas requirements in Texas can be met for some time, but the price will continue to rise, reflecting the cost of alternative fuels. The gas situation in Louisiana, however, is much less favorable. The on-shore gas production has reached saturation so that any significant additional supplies will have to come from off-shore leases. Production and sales from these federal off-shore leases are regulated by the Federal Power Commission and, in all probability, a high percentage of this gas will be earmarked for the home owners. Therefore, this production will be of little or no help to ammonia manufacturers.

During the past several years, it has been impossible for interstate gas piplines to obtain enough new gas to allow for any growth and, therefore, they have been unable to take on new customers on a firm basis. So far, they have been able to cope with this situation by exercising their option to restrict sales under their interruptible contracts with industrial users.

The Federal Power Commission is dedicated to assuring a dependable supply of gas to householders and institutions, and if this growing segment of the market is to be supplied, it will be necessary to continue reducing the quantity being sold to industrial users.

In 1969, the gas consumed by industry and electrical utilities represented 61% of the total gas used in the U.S., with the other 39% going to all other types of users. Referring to Figure 1, it can be seen that the gas available from all sources in 1975 will be 123% of what it was in 1969. However, the demand by preferential users will be about 146% of what it was in 1969. Therefore, industry will be reduced from 61% of the total gas used in 1969 to 54% of the total gas used in 1975. This means that industry's curtailment will then amount to 11.5% of their earlier supply, or stated differently, an average interruption of 42 days/yr.

It's probable that ammonia plants which have intrastate gas supplies will not be affected by curtailment, but they will be directly affected by increases in the price of gas, as their gas contracts run out. So, we have on one hand the ammonia manufacturer using intrastate gas having all the gas he needs with the price going up drastically as he renews gas contracts, and on the other hand, the purchaser of interstate gas being protected from drastic price increases, but having his supply of gas severely curtailed. As was shown above, 35.2% of the respondents to the questionaire have intrastate contracts, and 64.8% have interstage contracts.

The gas supply situation in the United States could be further complicated if suggestions made at a recent Congressional hearing are carried out. The hearing was urged, by the chairman of the Public Service Commission of one of the northeastern states that is feeling the results of the gas shortage, to broaden the Federal Power Commission's jurisdiction to include intrastate as well as interstate gas supplies. If Congress were to do this, it would almost certainly lead to end use controls of all natural gas in the contiguous 48 states, and the result would be utter chaos as the various consumers in the country compete for the available supplies.

Cost of Gas

Not too long ago, when an engineer was asked to do an economic study on a natural gas consuming process on the gulf coast, he automatically used 20¢/million for the gas. Those days are gone forever. Intrastate gas is being quoted in Louisiana this year at over 40¢/million B.t.u. and gas producers are now talking about 50¢/million B.t.u. for new gas supplies in Louisiana.

The industrial users of gas, including ammonia manufacturers, that are unable to obtain enough gas for their needs will be forced to convert at least some of their fuel requirements to fuel oil. It is expected that by 1975, an off-shore refinery, processing foreign crude oil, will be selling its low sulfur fuel oil on the U.S. Seaboard at about 70¢/million B.t.u. This will push the price of new intrastate gas to about 70¢/million B.t.u. in 1975.

Using published data on modern centrifugal type ammonia plants, we compared the cost of producing ammonia in a 600 ton/day plant that was built in 1965, at a cost of $10 million dollars, at the gas prices in 1970 and at the gas price projected for 1975. This assumes the plant will

have to negotiate a new gas contract at that time. In addition to the increased gas cost. we escalated the power cost and the operating, material and maintenance costs to reflect present inflationary trends. This comparison revealed that while this plant could return 9% after tax, at $25.00/ton, F.O.B. plant in 1970, by 1975, the same plant would have to sell its ammonia at $39.00/ton to realize the same 9% return on investment after tax.

So far we have been talking about domestic ammonia produced from domestic gas. With the very high price of imported LNG, and the even higher price of SNG from imported naphtha, it can be seen that if new ammonia manufacturing capacity is to be built in the U.S., it will have to be based upon domestic natural gas. But then the question arises, What about converting the natural gas that is available off-shore to ammonia, and then importing the ammonia?. In order to investigate this possibility, we looked around for a current supply of natural gas that was available reasonably close to the gulf coast of the United States. We found that a proposal had been filed by a large U.S. oil company with the Federal Power Commission showing an LNG cost delivered to the U.S. of 93c/million B.t.u. This was based upon liquifying gas from a newly discovered large gas reserve in the Caribbean, north of Trinidad. The proposal listed the gas cost into the liquifaction plant at 12.5c/million B.t.u. So, it was decided to compare the economics of using this gas in a new 1,000 ton/day ammonia plant to be built in Trinidad in 1975 with the same new plant built on the gulf coast of the United States in 1975, and using 70c/million B.t.u. Because of inflationary trends, the cost of a new 1,000 ton/day ammonia plant on the gulf coast in 1975 would be approximately $24.5 million, while the same plant built in Trinidad at the same time would cost approximately $27 million. Again using a return on investment of 9% after taxes, the ammonia manufactured on the gulf coast would have to sell at $46.50 a ton. On the same basis, the ammonia from Trinidad could sell for $40.20 a ton. This includes $8.00/ton for shipping and terminal costs. From this example, it can be seen that imported ammonia will become a threat to the ammonia manufacturing industry in the United States. The first effect of this foreign competition will be to stymie the construction of new ammonia plants in the United States by 1975. Secondly, if agricultural ammonia imports are left uncontrolled, older plants that have to renegotiate their gas contracts will be unable to compete with ammonia imports, because these new contracts will certainly be at higher gas costs than the present contracts.

No Protection Now

At the present time, there is no protection whatsoever from agricultural ammonia importation. There is, however, a $15/ton duty on ammonia imported for use other than agricultural. It seems clear that if the federal government persists in its tariff policy for imported agricultural ammonia, the new ammonia plants built after 1975 will be off-shore. These plants will enjoy relatively cheap gas while paying no tariff on the ammonia they export to the U.S.A. While these plants may, in all probability, be built by American firms, this government policy will force investment and job opportunities out of the United States.

If there is one thing hindering a solution to the energy crisis in which the United States now finds itself, it's the complete unawareness by the public and government of the seriousness of the situation. As engineers, we have a duty to our profession and to the industries for whom we work, to see that the public and our congressmen are made aware of the seriousness of the energy shortage.

In Summary

The future of the ammonia manufacturing industry in the United States will not be without problems. The gas shortage is already affecting the ammonia industry and the situation promises to get worse. Whether new gas or alternate fuels are used by the ammonia industry, there is one thing certain - the cost will be higher. With higher costs for fuel and feedstock, the ammonia industry in the United States will most certainly be facing serious competition from foreign ammonia in the last half of this decade.

DISCUSSION

Q. On the restrictions that you mentioned, what percentage of those restricted had firm gas contracts?

SLOAN: I have a confession to make. That last paper interested me quite a bit, because we blew up the transfer line between our waste-heat boiler and the feed gas heat exchanger just before I left, and in the rush of getting out of there I left the raw data on my desk, and there was no way to get it here in time. I really can't answer it. The only data I have with me is what's in here. I'm real sorry about that, but I had the reporters and the radio station and newspaper and everybody on my back, because it made quite a commotion around town. Our plant's right inside the city limits, and the expansion joint failed catastrophically. One additional thing – the question hasn't been asked. I was prepared for it. The public feels that the gas industries are holding back gas, they're not exploring for it, they're forcing a higher price. Well, we're not exploring for it, because we do need a higher price to make it economical. But to give an idea, if we had an all-out push right now on exploring for gas, it would take a lot of money. Regardless of who does it, it takes money. In the period 1955 to 1970, the domestic petroleum industry spent 68 billion dollars on exploration. This represented 653,000 wells.

Now if we were to increase that to what we feel will be the requirement by 1985, we'd need an additional 50 billion dollars investment. That's a total of 118 billion dollars. All right, where does money come from? It comes out of your coffers. Some of it is from the corporation, but a large percentage of it is borrowed capital that you get from the investment banking concerns. They have certain restrictions on – or criteria on which they base their loans. They are based on cash flow, the capital worth, the debt that you already have, how much you can support, and there are complicated formulas for arriving at how much money can be loaned.

Unfortunately, if you get through all the mental gymnastics and math, you find that by 1985 there will have

only been available 85 billion dollars to carry on this 118 billion dollars worth of exploration that's needed. So we have a financial reason for its becoming almost an imposibility.

Q. At what cost for gas and in liquid feed stock would you estimate that we might take a step backward in technology and go back to making gas from coal or coke?

SLOAN: I haven't worked the cost on gas. We looked at partial oxidation of a heavy crude oil. This was an available process, something that the engineering companies have out in their active file, instead of the coal which is inactive. I do feel that we're getting to a point where coal will become a reality, that we'll go back to it, so to speak.

Q. Could you hazard a guess about how many years away that might be?

SLOAN: Oh, I think, as a conservationist more than an engineer, I think we should be dusting off the process right now. I think we're using a valuable raw material that we're not going to be able to replace, where we could be using coal. The problem is, everybody turned their back, they had their head in the sand on this energy situation; nobody would face up with it until we're so deep into it that we've really plundered our petroleum reserves, and we haven't our coal. The environmental push has hurt the situation, because there are a lot of power companies firing distillate fuels or low-sulfur fuels, or even gas, that previously have been firing coal, and they were made to convert. So I think this is a subject that the Institute or our profession as a whole should get involved in, and quickly, as to when this becomes economical, and whether or not it's economical or if there is some force to make it come about, I don't have the answer as to your question on the dollars.

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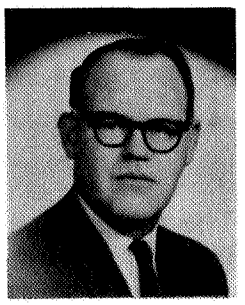

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