sure in the fire lines to be maintained by means of a jockey pump, or by city water pressure, or by gravity tank riding on the line. If power source is not reliable, a stand-by gasoline engine should be provided for operation of the fire pump in the event of a power outage.

Stand-pipes to be located in the extraction building, to which fire hoses, equipped with combination straight stream and fog nozzles, are attached.

Portable fire extinguishers of the dry powder type are to be located strategically throughout extraction building.

Hose houses are to be located around the extraction area which are equipped with connected fire hose and combination straight stream and fog nozzles. Spanners and hydrant wrenches to be available in each house.

Employees are to be trained in use of fire-fighting equipment.

Purging for Repair or Inspection

All solvent equipment is to be purged and tested safe before opening for inspection or repair.

Equipment containing solvent or miscella is to be emptied and then purged with steam. Purging is to be continued until no solvent can be detected, using a portable, combustible gas indicator.

The extractor cannot be purged with steam because of the presence of flakes. An extractor which has been emptied of flakes and miscella may be safely purged, as follows.

A purge blower with a capacity of one extractor air change per minute is permanently connected to the bottom of the extractor. With purge valve open but blower off, carbon dioxide is admitted to the top of the extractor, thus displacing the solvent vapor downward. The vapors issuing from the purge line are dispersed by means of a steam jet. When enough carbon dioxide to fill extractor has been added, extractor cover is removed and purge blower is turned on. At same time a quantity of carbon dioxide equal to one-half the volume of the extractor is rapidly admitted to the top of the extractor. In this manner the solvent vapor is displaced with air without going through the explosive range. Atmosphere in extractor is frequently checked with a portable analyzer to be sure atmosphere is free of solvent and solvent vapor before anyone enters the extractor.

In the event of an extractor breakdown in which the flakes cannot be removed, the miscella is allowed to drain and is pumped out of the extractor. Under these conditions a carbon dioxide purge would be ineffective since the flakes would still be saturated with liquid solvent or miscella. Under these conditions the extractor cover is removed, and the purge blower turned on. Rapid evaporation of the solvent causes the temperature to drop quickly. This slows down the evaporation rate, and within about one hour the atmosphere leaving the purge blower is well below the lower explosive limit. The purge blower is kept running, and the atmosphere is checked with the portable analyzer. Usually after 24 hrs. the concentration is below 10% of the lower explosive limit. Any repairs made at this time must be made with the purge blower running, using only spark-proof tools. Flakes may be removed by carefully scraping off top layer and letting solvent in layer below evaporate before scraping off another layer.

With the large volume of air flowing through the extractor there is no immediate explosion hazard. However ignition at the surface of the flakes would undoubtedly cause a serious fire, which could result in a disaster. Under breakdown conditions, using air as the purging medium, time and extreme care are the most important factors. Sufficient time must be allowed to do a reasonable purging job before attempting repairs.

After repair and before start-up, air is removed from extractor by admitting carbon dioxide into the bottom of the extractor and forcing air out through the vent system. After filling extractor with carbon dioxide, solvent is admitted and circulated. With this procedure, going through the explosive range is avoided.

Inspections

A regular monthly safety inspection is to be made at each plant by an inspection committee appointed by the superintendent. An inspection outline proposed by the solvent committee is to be followed, and a written report made covering every item in the outline. Safety features are to be tested to determine that they will work as intended. Continuous solvent-detectors are to be tested quantitatively to be sure that they will give an alarm at the proper concentration.

Monthly inspection reports are to be carefully reviewed and commented on so as to keep them from becoming routine. Inspections are also to be made before starting up after each major shutdown. In addition, inspections are to be made by traveling members of the solvent committee.

The foregoing is a more or less condensed version of the principles laid down by the committee. These principles were taken into account in designing the plants, and detailed specifications were written covering many of the items. With the design of each plant, changes were made as dictated by experience. Thus the purging set-up has been enlorged upon so that in the newer plants it is possible completely to purge the plant in a matter of hours instead of days.

Complete detailed safety instructions were written for each plant, and these are periodically reviewed and revised, as necessary.

A small booklet, entitled "Safety for Solvent Plants," covering the principles involved in our safety program, was prepared and distributed to employees. The main object of this booklet is to stimulate interest in the safety program.

In this paper we have briefly outlined the solvent safety program used at our plants. In conclusion, I would like to quote a paragraph from our safety booklet: "SOLVENT-PLANT SAFETY IS DEPENDENT UPON BOTH MEN AND EQUIPMENT. THE FINEST AND SAFEST EQUIPMENT MAY BE INEFFECTIVE UNLESS OPERATED AND SERVICED BY SAFETY-MINDED MEN.—BE SAFE."

Safety in Design in Solvent Extraction

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WHEN WE LOOK BACK on the solvent extraction industry 15 to 20 years ago, we see that tremendous improvements have been made in safety practices as well as in general operating efficiencies. About 20 years ago, when I was working for Procter and Gamble Company, I was assigned to solvent-extraction operation. I recall that I was struck by the observation that so many of the early workers and inventors in the solvent-extraction field were now deceased. It seemed quite significant to me that most of the patent literature, which I read in order to gain as much information on the new subject as possible, showed that the heirs of the inventor, for the most part, made the patent applications. It appeared that most inventors working in this field did not live long enough to apply for their own patents. I never discovered whether or not they died of old age, but most of us assumed that we were getting into a fairly dangerous operation.

In talking with other old-timers in the industry, it is possible to recall and laugh at many occurrences which took place and which were not at the time laughing matters. My company went into solvent extraction as a brand new venture after a great deal of research and development and economic study. At that time the economic reasons for solvent-extracting soybeans were almost overwhelming. It was possible to recover a million-dollar investment in less than one season's operation.

After the decision had been made, we purchased a solvent-extraction plant from Germany, which in due course was constructed and loaded on a boat for shipment to the United States in September, 1939. Back here at home we had already designed the plant and completed excavations and foundations and purchased a great deal of auxiliary equipment. When the outbreak of war prevented the shipment of the equipment, we came to The French Oil Mill Machinery Company, who had already indicated an interest in building solvent-extraction equipment. It was an ideal combination in that we had never operated a solvent-extraction plant before and French Oil Mill Machinery Company had never built one. I often think of the story about the recruit in the Army who had never ridden a horse before and told his instructor that fact in the hope of getting a gentle horse. The instructor's reply, as most of you have probably heard, was that he had an ideal horse for him which had never been ridden before. Possibly we had the same sort of combination in this first solvent-extraction plant. However we spent long and earnest hours in working out designs and practices which would insure safe operation. Since that time I have been associated with and have been responsible for the design of about 60 solvent-extraction installations and, like W. F. Bollens of Swift and Company, I can say that none of these installations has had a serious incident with respect to fire or explosion. Possibly some of my views would be somewhat different if I had personally experienced such an occurrence.

Since other papers in this symposium have covered the subject of safety thoroughly, it is my thought that I might best present certain detailed items, based on 20 years of contact and observation in this field. Regulations and restrictions that we run into in different states and in dealing with different insurance companies are varied and sometimes contradictory.

MOST RULES and regulations and the thinking of many insurance companies and public officials concerned with safety are with respect to minimizing losses caused by fires and explosions which have already occurred. This seems to me the wrong approach and my chief interest in safety deals in preventing such a fire or explosion in the first place. The other viewpoint is important, of course, but sometimes there is a conflict which I think should always be resolved in favor of the positive approach of preventing a fire or explosion rather than minimizing damage of one that does occur.

The first principle in safety is that a plant running uniformly is a safe plant. Consequently any restriction that makes it more difficult to operate the plant uniformly and continuously is a bad device.

Another most important principle is that safety in the final analysis depends upon supervisory and operational personnel. Consequently any rule or regulation which complicates procedures for supervisors and operators should be regarded as a hindrance to safety and not a help. Some of the contradictions we have encountered follow.

In some localities we have been told that we must bury our solvent-storage tanks. In other localities we have been told that by no means are we allowed to bury a solvent-storage tank. I personally like to keep everything above ground where it can be seen and inspected.

For this reason I have never liked so-called safety dump tanks into which all above-ground solvent, miscella, and oil can be dumped in case of fire or suspected fire. The use of such tanks also makes more complicated the piping system with extra valves that provide chances for mistakes. We do however favor automatic overflow from the solvent work-tank to the solvent storage-tank. By proper design an above-ground solvent storage-tank can be set at an elevation permitting this safety feature. All of our standard plants have it.

Fire-walls are a very good device to separate hazardous operations from each other and from less hazardous operations. In general, processors and regulatory bodies have favored isolation and distance between such operations rather than fire-walls. The advantage of fire-walls is to bring such operations closer together where supervisory and operator control is easier. This great merit should not be overlooked.

I have never been able to see merit in the use of carbon dioxide purging or the use of inert gas. If safety rules are set down such that no machinery can be moving during the time that purging is being accomplished, it seems to me that air, steam, and hexane or other solvent fumes themselves are the very best purging agents. Inert gas purging provides a complication which has no value.

For the same reason I do not favor regulations concerning isolation of solvent work-tanks or other storage-tanks. Such things make it more difficult for the operator to maintain his whole process under personal observation and control.

Some states have rules requiring the installation of solvent storage-tanks remote from the extraction area. This rule is bad for several reasons. One hazardous area is much better than two. If the solvent storage-tanks are close to the extraction area, they can be vented through the efficient vent system of the extraction plant. This is very desirable from both an economic and a safety standpoint.

I have observed that frequently regulations allow operations to be conducted in so-called "pressurized" areas that otherwise are not allowed. Many times no restrictions are given as to the technique of pressurizing an area. Obviously, if air is sucked into a room in order to maintain a positive pressure, the source of this air is most important.

THESE HAVE BEEN a few personal observations and opinions. It is very difficult to lay down a set of rules which can be applied to all installations. The design of a safe installation must be a completely individual and integrated operation. It is difficult for most people to realize the influence that existing installations and conditions have on a properly designed plant. We have made about 60 of these installations, and none of them have been alike and should not have been alike. For every individual installation, all of the factors existing must be taken into account in order to work up a safe installation. A few of the considerations involved are location and arrangement of existing buildings, slope of the ground, and the relation of all existing facilities with relation to the slope of the ground, reliability of the electric power, reliability of the water supply including fire protection water, location and adequacy of sewers including the eventual disposal of sewage, type of ground, whether the area is subject to floods, and even the direction of wind. All are part of a properly designed installation.

Finally, in working up a safety program for solvent-extraction plants, it must be held in mind that ordinary and usual safety considerations must not be minimized because of the emphasis on special safety considerations. A man can just as easily catch his heel on a stairway and break his leg in a solvent plant as he can in an ordinary building.

An important improvement in safe operation in the last 15 to 20 years, during the time that I have been observing this operation, has been the simplification of extraction plants themselves. Improvement in engineering and operating efficiency makes for a safer plant in itself. Combined with this has been a corresponding improvement in the efficiency of safety devices and in safety design.

Safety in Solvent Extraction from the Viewpoint of Insurance and Practical Operation

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When the A.O.C.S. Technical Safety Committee met in Houston in the spring of 1956, one of the principal topics of discussion was the proposed schedule for rating solvent-extraction plants in Texas. With this in mind, two questions present themselves: why is a rating schedule of this type necessary, and what functions are accomplished by such a schedule? Please bear in mind that we are not opposed to having a rating schedule of this nature. Certainly a schedule is necessary from an insurance standpoint, and it is helpful in many other ways, such as serving as a guide for new construction and as a spot check on various phases of safety in every-day plant operations. If solvent extraction itself is a practical operation, then any schedule that is adopted necessarily must be made to produce an equitable rate, and it also must be practical from an operator's standpoint. We have cooperated wholeheartedly with state agencies and interested insurance companies in trying to make this schedule practical as well as realistic, something we feel that the industry can live with. Thus far the undertaking has proved to be a sizeable task. We are confident that with enough effort and with men and committees, such as the one we have here, working at it, we shall come up with a schedule that will prove to be beneficial to all concerned.

The State of Texas has under consideration a proposed schedule for rating continuous process solvent-extraction plants, using flammable liquids having a closed cup flash point below 110°F. There are nine of these plants now operating in Texas; eight extract oil from cottonseed and one from rice bran. There were formerly two "rice" plants; however one has ceased operation. Four of the cottonseed plants and the one handling rice are insured in "admitted" companies, and it is understood that the others are insured by "non-admitted" organizations.

At the present time there is no schedule for rating these plants in Texas and, so far as can be determined, there is no schedule in any of the rating jurisdictions. The process is relatively new here, and it is believed all who have assisted in setting up the proposed schedule will admit that it has been erected on a judgment basis. It is recognized that there is no other way; however it is believed the end-safety result should be weighed against the end result in the application of an existing schedule which has some common hazards or processes. Again, there is no credible experience, so far as is known, to which this proposed schedule can be tied. It is believed that knowledge gained as operators should enable us to suggest improvements as well as to point out the obvious inequities of the proposed schedule. This proposed schedule, like that for petroleum properties, is unusual in that it provides on page 16 that "this rating schedule is complete in itself and rates produced hereunder are not affected by rating rules contained elsewhere in G.B.S." Again it is unusual and follows the petroleum properties schedule in making inherent explosion coverage inseparable from the fire coverage, providing a combined fire and inherent explosion rate. This proposed schedule which is set up for solvent plants, using flammable liquids having a closed cup flash point below 110°F., stresses the principal fire and explosion hazard as being from the flammable solvent used in the process.

Similarities to the Texas Petroleum Properties Schedules and the fact that flammable liquids are indicated as the chief hazard suggest that the gasoline plant schedule (Texas General Basis Schedules for Petroleum Properties, pp. 22–24) is the nearest one we can find for comparison with the solvent plant. Gasoline plants deal entirely with light liquids and gases, at high pressure (600–3,000 lbs. and in rare cases up to 5,000 lbs.) and at high temperatures (700–900°) whereas the solvent plants under consideration deal with solids and liquids at low pressure (atmospheric or vacuum) and at low temperatures (under 230°F.), which are below the ignition point of the solvent. They may also carry a maximum absolute steam pressure of 140 lbs. on some of the steam-jacketed vessels. This is for heating purposes only.

For comparative purposes, minimum rates will be used since they represent those plants built according to standards with all superior feature credits applied. Any deviation from standard either in construction or occupancy will be represented in the deficiency charges. Therefore for a true comparison only minimum rates should be used.

It appears that the gasoline plants, dealing in higher pressures and temperatures and in lighter