HEATEC TEC-NOTE

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HEATERS FOR GAS PROCESSING

A number of gas facilities use Heatec heaters when processing natural gas. When gas is extracted from oil/gas wells it contains water and contaminants that make it virtually unusable for pipeline distribution. It must be processed to make it suitable for residential, commercial and industrial users.

Treating the gas involves removing hydrogen sulfide (H_2S), carbon dioxide (CO_2), and moisture. The following information applies to a typical plant using Heatec heaters.

- H_2S and CO_2 are removed from the gas by passing it through liquid amine.
- Moisture is removed from the gas by passing it through dehydration beds.

With use the dehydration beds and the amine solutions become saturated and must be regenerated to restore their effectiveness. Heatec HMO heaters and Heatec REGEN heaters are used to regenerate amine solutions and the dehydration beds.

REGENERATION OF AMINE

Gas that contains an appreciable amount of H_2S is known as sour gas. When it contacts the amine, the amine absorbs H_2S and CO_2 and it becomes sweet gas. It may also go through a glycol solution to absorb any residual moisture.

When amine becomes saturated with those contaminants, it is no longer effective and is known as rich amine. It must be regenerated to restore its function so it can be reused. After amine is regenerated it is known as lean amine.

Figure 1 illustrates how an HMO heater is used to regenerate amine. (The process for regenerating glycol is similar.) The heater heats thermal fluid, which circulates through a reboiler. The reboiler heats rich amine from the regenerator. Heating strips H_2S and CO_2 from the rich amine, converting it back to lean amine. Lean amine is then circulated back to the contactor.

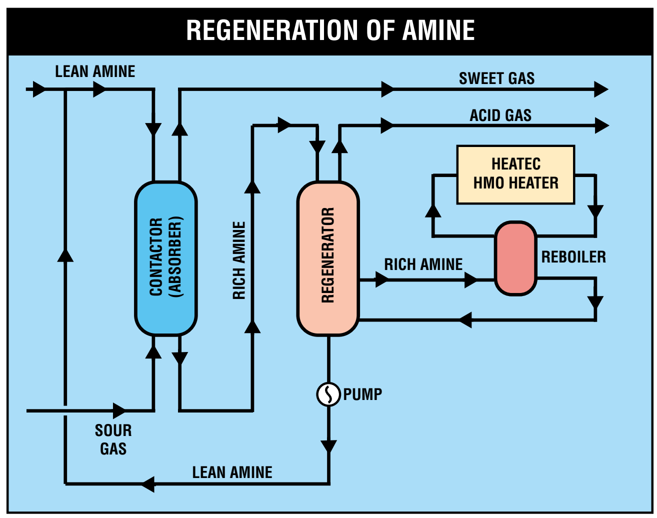

Figure 1. HMO heater regenerates amine by circulating hot thermal fluid through a reboiler.

REGENERATION OF DEHYDRATION BEDS

Gas that contains moisture is known as wet gas. When it goes through a dehydration bed, solid desiccant in the bed adsorbs the moisture and the wet gas becomes dry gas.

When the desiccant becomes saturated, it is no longer effective. It must be regenerated by heating it with dry gas diverted from the mainstream of dry gas. One of two methods may be used to heat the dry gas:

- Direct method
- Indirect method

DIRECT METHOD

The direct method is to pass dry gas operating at high pressures directly through the heating coil inside a heater. Heaters that heat gas directly are known as REGEN heaters. Their coils are specially designed to withstand high pressures.

Figure 2 illustrates a REGEN heater and two dehydration beds. Bed No. 1 is removing moisture from wet feed gas. The bed will need to be regenerated after several hours of use. Meanwhile, Bed No. 2 is being regenerated.

Regeneration of the bed is achieved when dry gas is heated to a temperature high enough to vaporize the moisture.

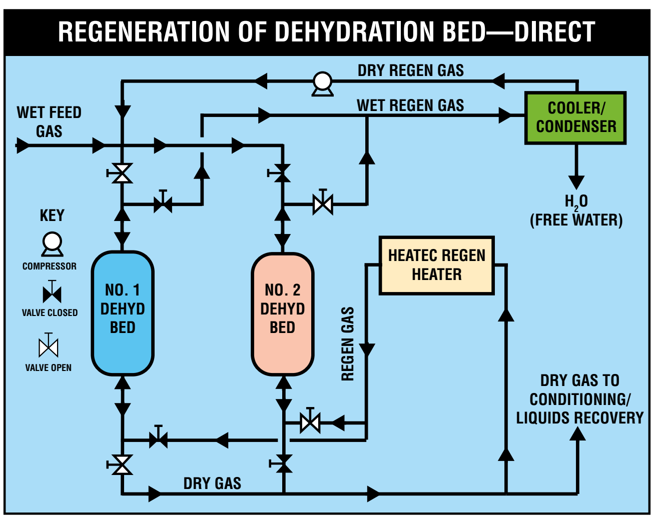

Figure 2. REGEN heater regenerates dehydration beds directly by circulating hot gas through the beds.

INDIRECT METHOD

The indirect method is to heat the dry gas by passing it through a heat exchanger instead of directly through the heater. The heat exchanger is heated by thermal fluid that is heated by a heater known as an HMO or Heat Medium Oil heater. These heaters operate at relatively low pressures.

Figure 3 illustrates the indirect method. The heated gas is used in the same way to regenerate the desiccant beds as in the direct method.

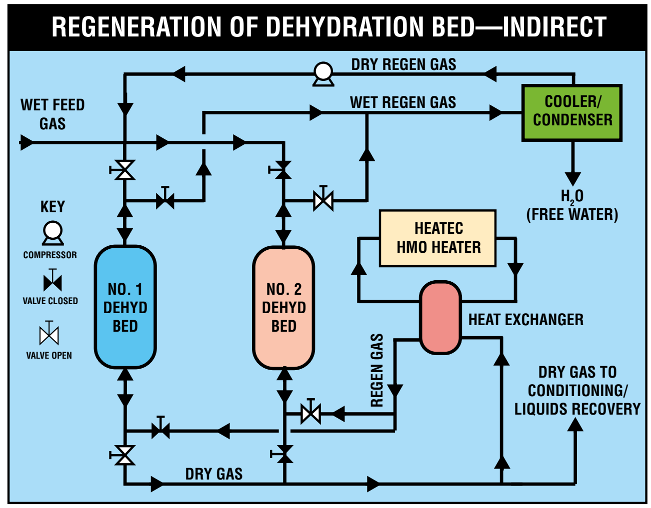

Figure 3. HMO heater regenerates dehydration beds indirectly by circulating hot thermal fluid through a heat exchanger.

This facility uses two Heatec REGEN heaters to regenerate its gas treatment system. Each heater has an output of 7.1 Btu/hr. One of the REGEN heaters is in the foreground.

This is a two-pass HMO heater used to remove CO_2 in treatment of natural gas at a facility in California. It is vertically up-fired with an output of 13.4 million Btu/hour.

A three-pass HMO heater is part of this Heatec heating system for processing oil and gas on an offshore platform in the Gulf of Mexico. The system is designed for an explosive atmosphere.

OTHER HEATER APPLICATIONS

Heatec heaters are also used in other ways for gas processing. For example, HMO heaters are used to convert LNG (liquefied natural gas) into the gaseous state for pipeline use. Heatec heaters are also used for fractionation, a process that separates propane, butane, ethane and other products from NGL (natural gas liquids).

ANNOTATIONS

The foregoing information is displayed on a wall plaque at Heatec. The purpose of the wall plaque, as well as this document, is to give a little insight into the *typical* role of Heatec heaters in the gas processing industry.

Because of the limited space on the plaque its explanations are very condensed. So you may wish to review the following information for a somewhat more detailed explanation. But be aware that even this information is still very limited compared to the vast amount of information available on how natural gas is processed.

Natural gas is an extremely valuable resource in our world today. It is found in abundance in the United States. But unlike the air we breathe and the water we drink, natural gas—in its natural state—requires extensive processing to make it suitable for distribution and use.

Two 60 million Btu/hour Heatec heaters convert LNG into natural gas for pipeline distribution at this gas plant in Chattanooga, TN. LNG is stored in the large white tank in the background.

Because there are so many variations in the actual ways that gas is processed, our use of the word *typical* is a bit of a stretch. Nevertheless, there are several things that are common to virtually all variations in processing.

Processing is required in order to separate water and various contaminants found in virtually all natural gas while it is in its raw state. Some of the components in natural gas are valuable as separate products. And some components must be removed to make the remaining gas suitable for distribution and use.

Absorption and *adsorption* are perhaps the two most common techniques for extracting moisture and unwanted components. Technically there is a difference in the meanings of these two terms, which we will not attempt to define here. But it may help to know that *liquid* solvents are used as *absorbents* whereas *solid* substances are commonly used as *adsorbents*.

Amine and glycol are two of the most common liquid solvents used as *absorbents*. Amine absorbs H_2S and CO_2. According to one source of information amine solutions are used to remove hydrogen sulfide in 95 percent of the U.S. gas sweetening operations.

Glycol absorbs water and can be used to dehydrate natural gas.

Several types of *solid* desiccants are also used to dehydrate natural gas by the process of adsorption. Solid desiccants are somewhat more expensive than glycol, but are also somewhat more effective. Three types of solid desiccants are in common use: alumina, gels, and molecular sieves. Molecular sieves are used at certain plants where Heatec heaters are used.

One thing that both the liquid and solid substances have in common is that with use they become saturated with the targeted substances. Saturation causes them to lose their ability to absorb/adsorb those substances.

Fortunately, these substances can be restored to a useful state by a process known as regeneration. And it is the regeneration process where Heatec heaters play an important role.

The following information provides a detailed explanation of the regeneration processes illustrated in Figures 1, 2, and 3.

FIGURE 1

Figure 1 shows H_2S and CO_2 being removed from the gas stream by chemical reaction with an amine solvent solution in a reversible process. In a reversible process the solution removes H_2S and CO_2 in the contactor at high pressure and/or low temperature. The reaction is then reversed by high temperature and/or low pressure in the regenerator. The process flow is as follows:

Sour natural gas enters the bottom of the contactor and rises through the contactor. It contacts the lean amine solution flowing down from the top of the contactor. Acid gas components (H_2S and CO_2) are absorbed by the amine.

The sweetened gas leaves the top of the contactor. Sweet gas leaving the contactor is saturated with water and normally requires dehydration.

The *lean* amine solution becomes *rich* amine as it extracts H_2S and CO_2 from the sour gas and passes out the bottom of the contactor.

The rich amine goes to the top portion of the regenerator. As the solution flows down the column and circulates through the reboiler, it is stripped of H_2S and CO_2.

The amine solution leaves the bottom of the regenerator as lean solution. It is recirculated to the top of the contactor.

Acid gas stripped from the amine passes out of the top of the regenerator.

The reboiler is a heat exchanger that receives its heat from hot oil (thermal fluid). The oil is heated by a fired heater as it circulates through the reboiler. This type of heater is known as an HMO heater and is one of several types made by Heatec.

FIGURE 2

Figure 2 shows use of two dehydration beds. One dehydrates the feed gas while the other is regenerated after becoming saturated from use.

The beds contain a solid desiccant that adsorbs moisture from the wet gas, leaving the gas dry.

Figure 2 shows the direct process, which uses a REGEN heater for the regeneration process. The valves are set so that Bed No. 1 is dehydrating the wet gas while Bed No. 2 is being regenerated. The process flow is as follows:

Figure 2 shows wet feed gas piped to the tops of both dehydration beds. It flows through the open valve at the top of Bed No. 1 and down the bed.

The valve at the top of Bed No. 2 is closed, so no gas flows through that bed at the present time.

Desiccant in Bed No. 1 adsorbs moisture from the gas as it passes through the bed. The gas becomes dry by the time it exits the bottom of the bed.

However, it may still contain other components that will be extracted during further processing stages.

As the process continues the desiccant in Bed No. 1 becomes progressively more saturated. However, the bed is switched before it loses its ability to adsorb moisture.

The dry gas flows out of the bottom of Bed No. 1 and through the open valve where it enters the mainstream of dry gas headed for further processing (not shown in the illustration). A small stream of dry gas is diverted from the mainstream. It flows through the REGEN heater.

The gas is operating at high pressure. Accordingly the coils in the heater are designed to operate at a pressure much higher than most other heaters.

The *dry* gas diverted through the REGEN heater is heated as it flows through the heater.

It flows from the heater through an open valve into the bottom of Bed No. 2. Hot dry gas flows up through the bed and regenerates the desiccant by vaporizing virtually all the moisture adsorbed by the desiccant. The hot gas now carries the moisture with it and exits the bed as *wet* regen gas.

After operating in this mode for a period of time, the valves are switched so that Bed No. 1 can be regenerated while Bed No. 2 dehydrates the wet feed gas.

FIGURE 3

Some systems do not use a REGEN heater, but use an HMO heater and a heat exchanger instead. Figure 3 shows this type of system.

The system works the same as the direct method except that the dry gas is heated as it flows through the exchanger. Gas does not flow through the heater.

The HMO heater heats thermal fluid and circulates it through the exchanger. The thermal fluid operates at a much lower pressure than REGEN gas. Accordingly the coil in the heater does not have to be designed for high pressure.

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RESOURCES

Engineering Data Book, Tenth Edition 1987, published by the Gas Process Suppliers Association:

- Section 1 General Information
- Section 19 Fractionation and Absorption
- Section 20 Dehydration
- Section 21 Hydrocarbon Treating

Websites:

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