Technologies of gas treatment by amine purification

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Sulfur compounds, mainly hydrogen sulfide, are present in almost all types of natural gas. This is especially true of associated petroleum gas, APG, which is produced together with oil. APG is a valuable natural resource that, until recently, had to be flared due to a lack of on-site processing technology. However, the Government Decree of November 8, 2012 № 1148 "On calculating charges for negative impact on the environment when emitting pollutants into the atmosphere due to flaring and (or) dispersal of associated petroleum gas" explicitly requires the utilization of at least 95% of APG. Associated petroleum gas could heat and light field clusters, providing fossil fuel production with the necessary energy.

According to statistics,
up to 35% of total costs
are spent on energy supply for remote facilities.

GOSTs 5542-2014 and 27577-2000 limit the hydrogen sulfide content at 0.02 g/m^3 in combustible gases that can be used as fuel in boilers or gas-fired electric generators.

However, the content of hydrogen sulfide compounds in gas, for using it as fuel or raw material according to regulations is not more than 0.02 g/m3 (GOST 5542-2014 "Combustible natural gases for industrial and municipal purposes" and GOST 27577-2000 "Natural compressed fuel gas for internal combustion engines").

The reason for this is the diverse and intense corrosive activity of hydrogen sulfide. Dissolving in water, hydrogen sulfide forms sulphuric acid, which causes chemical corrosion of pipelines and units. Sulfides, which hydrogen sulfide forms in the presence of moisture practically with all metals play a role of cathodes in galvanic pair that leads to fast and extensive wear of all metal parts contacting with gas. This specific hydrogen sulfide corrosion cannot be completely removed by anti-corrosion additives.

Moreover, combining with unsaturated hydrocarbons, hydrogen sulfide forms mercaptans, which are toxic compounds and catalytic poisons, passivating downstream gas processing catalysts.

The desulfurization of produced gases has long been implemented in the industry and counts dozens of methods, which can be divided into two categories: sorption and catalytic.

Sorption technologies of desulfurization are based on absorption (by solutions of amines, alkalis) or adsorption (by solid adsorbers) of hydrogen sulfide and other sulfur compounds with their subsequent extraction and regeneration of sorbents or without it, in case of using chemisorbents.

Catalytic technologies usually imply reductive hydrogenation of all sulfur-containing compounds to hydrogen sulfide with further gas purification from hydrogen sulfide by one or another method.

Often a combination of several technologies is used in the purification process, such as catalytic hydrogenation + absorption on a solid sorbent for gas post-treatment in methanol production, or catalytic hydrogenation + absorption by amine solutions in fuel purification.

Hydrogen sulfide generated as a byproduct in the purification process is typically converted by the Claus method to elemental sulfur for further industrial use.

The amine purification as an absorption method has been known since the 1930's when it was developed, patented and first used in the USA. Then gases were purified with phenylhydrazine. Since then, the technology has evolved and is widely used today.

Currently, different types of amines are used, which, along with the concentration of the working solution, determines the quality of purification, selectivity of the process and the corrosiveness of the working solution.

Amine	Concentration and purpose
Monoethanolamine (MEA)	➢ 20% for CO_2 and H_2S purification, ➢ 32% for CO_2 purification
Diglycoliamine (DHA)	➢ 20...25% for H_2S and CO_2 purification
Methyldiethanolamine (MDEA)	➢ 30...55% for selective purification from H2S in the presence of CO_2 ➢ for purification from H_2S and CO_2 is suitable when piperazine is used as an activating agent
Diglycoliamine (DHA)	➢ 50% for purification of H_2S and CO_2 ➢ Up to 70% for purification of "light" mercaptans

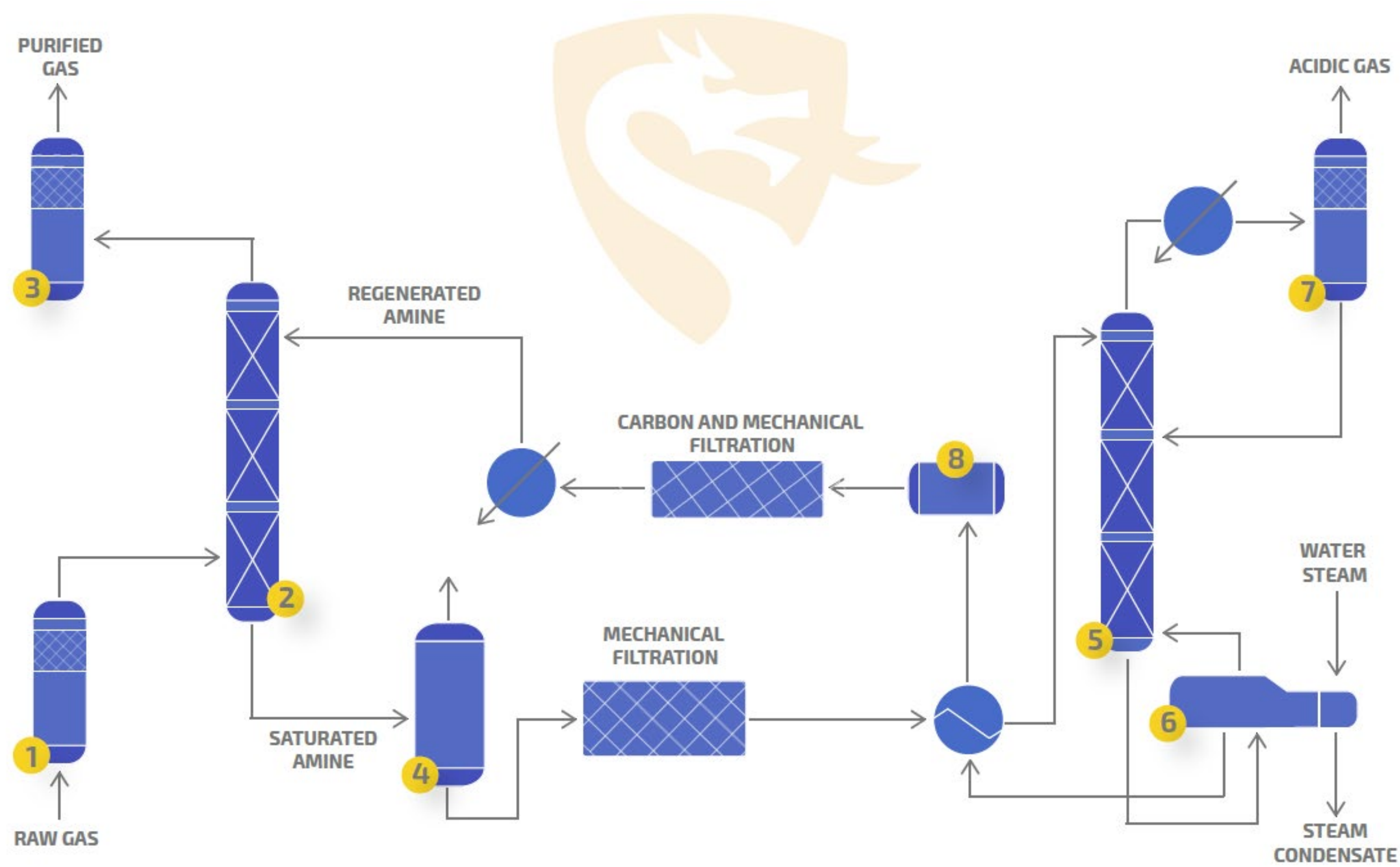
However, most of these technologies are designed for large volumes and are quite complicated. For example, the traditional hydrotreating technology requires temperature of about 300 C and pressure of about 3 MPa.

The process of amine purification of sulfur-containing gases by IG "Safe Technologies" is designed for small gas flows of about 1000 nm^3/h and uses MDEA as a working medium. Saturated amine solution from the base part of the absorber enters the expander, where the:

- ➢ separation of hydrocarbons contained in the solution,
- ➢ partial degassing of the flow

take place.

Separated gases from the upper part of the unit are directed to the **flare header**. The stream of saturated amine solution from the lower part of the expander is fed for regeneration to the **desorber**, after preheating in the recuperative heat exchanger. The desorber is equipped with a high-performance unique regular packing of in-house make. Removal of iron sulfide particles and mechanical impurities is carried out in the unit of **dust collecting mechanical filters**



Then the vapor-gas stream enriched with H2S and CO2 exits the column and enters the air cooler, after which the gas-liquid mixture enters the reflux tank:

- from the upper part of the tank acid gas is discharged,
- water condensate flows into the lower part.

The liquid from the desorber base flows continuously into the shell space of the reboiler.

If the purified associated gas is used to generate electricity, up to 3 MW of electricity can be produced today at a gas-fired power generator from a gas flow of 1,000 nm^3/h, which was previously burned at the flare.

The advantages of the "Safe Technologies" IG process

include:

- a wide range of hydrogen sulfide concentrations in the gas coming for purification
- high absorption capacity of amine to hydrogen sulfide
- relatively low cost of components, availability of reagents
- high degree of factory readiness of gas treatment unit, which allows to quickly assemble and launch it on a production site at the oilfield
- high quality of purified gas, exceeding the GOST requirements, less than 20 ppm (<0.002%).

The modular design of the plant allows it to be assembled in the field as quickly as possible, modifications can be made to tailor the serial solution to the customer's conditions. The unit can be designed for harsh environmental conditions of the Far North.

Such gas treatment complex operates at the North-Mukerkamylskoye field, which is being developed by Gorny oil and gas company. The contract was implemented on a turnkey basis in a short time. Full range of works, from design and equipment manufacturing to installation at the field and commissioning was performed by "Safe Technologies" Group personnel.

up to 35%
of total costs
falls on power supply of the remote facilities

H_2S

< 20 ppm (< 0,002%)
content of H_2S in treated gas

up to 3 MW
of electric power can be generated with
1000 nm^3/h of the gas