ADSORPTION DEHYDRATION UNIT BY REGENERATION SU-AD.R

Introduction

Natural gas contains significant quantities of water vapor known to be the most common impurity found in natural gas. Water vapor leads to operational problems by hydrate formation, corrosion, high pressure drop. As a consequence, line plugging causes swirling flow which reduces flow efficiency. Water vapor also lower the gas heat value and block the gas flow because of line hydrate formation.

The dew point at which gaseous hydrate starts to condense depends on gas temperature, pressure and analysis and water content. Gas relative gravity and gas analysis also influence the hydrate formation temperature. Wet gas in the transportation system under high pressure can easily form hydrate at relatively high temperatures (approximate or higher than 20 °C). One way to prevent hydrate formation is to confine water vapor to a volume smaller than the volume necessary for gas complete saturation.

In case of wet gas, line minimum temperature must be higher than the temperature at which hydrate forms or, by reducing water content, gas dew point must be lower than the lowest temperature in the transportation system.

The adsorption dehydration unit removes water vapor from the natural gas stream at the point natural gas is delivered from the well field (production or underground storage facilities) into the transmission pipelines.

Adsorption is a chemical instantaneous and exothermic phenomenon. Adsorption is purely a surface phenomenon – a mass transfer unit operation described as follows: a fluid component is retained on the surface of the desiccant that the fluid encounters.

Free water coming from the production layer (brine) that results from vapor water condensation, and water coming from accidental or technological sources (fresh water) cannot be inhibited during the dehydration procedure, but it is removed by the separators upstream from the adsorbers.

During the dehydration process the wet gas flows via the adsorption tower containing a deliquescing adsorbant layer where water is retained.

Mass transfer from gas to adsorbent takes place within a zone where the water content of the desiccant increases up to saturation. This area called mass transfer zone or front of adsorption travels in the direction of the gas stream.

The saturated adsorbent must be regenerated (water is removed by means of a hot gas stream, then the adsorbent is cooled) on the basis of the equilibrium principle.

Technical constructive characteristics

The adsorption dehydration unit by regeneration of the desiccant bed comprises:

- two- and three-phase separators;
- tanks where impurities are stored, and disposal system complying with the requirements regarding protection environment.
- desiccant adsorbers;
- filters to remove solid impurities (desiccant dust) placed before the point the dehydrated gas enters the gathering or transmission pipelines;
- heat exchangers to heat the desorption gas;
- heat exchangers to cool the gas necessary to regenerate the adsorbent bed;
- heaters to heat the desorption gas;
- gas compressors;
- instrumentation necessary to perform a complete gas treatment cycle.

Operation

Adsorption

After traveling through the two- or three-phase separator, gas saturated with water vapor flows to the metering panel, and then enters the manifold. From here gas enters the upper part of the adsorption towers. The gas flowing up to down reduces desiccant bed floating which is caused by the gas high velocity during adsorption. Pressure shocks, fluid high velocities determine the bed to agitate, particles to break and to be entrained.

Water vapor separation by adsorption is discontinuing; thus, two adsorption towers are needed. The adsorption towers are functionally fitted within the cycle frequency. While one adsorption tower is on stream (12 hours), the other one is regenerating (8 hours) and cooling (4 hours).

Adsorption is possible due to the properties of some solids to attract and retain some substances on their surface as vapor or liquid.

When encountering the adsorbent bed, a part of the water vapor is adsorbed on the surface of the adsorbent until equilibrium is established. The adsorbate diffuses in the adsorbent pores. In the contact zone gas-solid water vapor is renewed by diffusion through the adjacent gas layers. Equilibrium and diffusion phenomenon are produced at the same time.

The heat of adsorption that is given off during adsorption determines the temperature to increase depending on the initial content of water. The heat of adsorption is transmitted to the gas flowing to the adsorption zone. When leaving the adsorption zone, the heated gas encounters a cold and

dry adsorbent bed. Heat transfer is reverse: the bed downstream the adsorption zone is heated, while the flowing fluid is cooled. However, the fluid leaving the adsorbent bed has a temperature higher than the inlet temperature. Two waves are present in the adsorbent bed: adsorption and temperature waves.

After the gas stream passes through the adsorbent bed at the lower part of the towers, the dehydrated gas, with temperatures of 20 ÷ 25 °C, are directed to the collectors and transmission pipelines.

A portion of the dehydrated gas in the collector of the dehydrating towers can be returned in the wet gas cycle (120 ÷ 215 °C) after the heater, in order to perform the tower desorption cycle.

Desorption (regeneration of desiccant bed)

To eliminate the water adsorbed and to reactivate loading, it is sufficient to decrease the partial pressure of water present in the bed surrounding the adsorbent.

Passing a dry gas through the tower loading is the simplest way to eliminate the water adsorbed. This is a slowly process and the water molecules that are held on the adsorbent surface are not eliminated.

The dehydration units use wet gas stream that is heated to a corresponding temperature to raise the saturation level of, and the completely remove the adsorbate.

Preheated gas enters the heater where their temperature is raised up to 180 ÷ 230 °C depending on the desiccant. After leaving the heater, the overheated gas is injected a portion of the dehydrated gas to increase the under-saturation (capacity to take the water held in the absorbent bed).

Overheated gas enters the desorption tower at the lower part, is saturated with desiccant water and exits the towers at the upper part. From the towers outlet collector, water saturated gas is cooled.

Cooled to 20 ÷ 30 °C, water vapor saturated gas carrying condensation water enters the separators. The free water retained is automatically disposed from the separators. After being separated, water vapor saturated gas enters again the gas stream to be submitted to adsorption at the upper part of the towers. This is possible if overpressure is ensured. Contrary, water saturated gas is used as fuel gas.

Cooling

Cooling of the adsorbent bed after desorption is the regeneration second phase (desorption + cooling). The high temperature of the adsorbent bed must be lowered by circulating cold gases up to a value closed to the temperature of the wet gases entering the towers for the following adsorption cycle.

The adsorbent bed is cooled by circulation or recirculation of cold dry gas to prevent saturation of adsorbent with water vapor or other impurities. The retention capacity of the adsorbent bed must not be impaired before starting a new cycle.

The desiccant bed is cooled to a value that ensures the temperature difference between the bed and the wet gas is ≤ 40 °C at the beginning of a new adsorption cycle.

Ordering code

The dehydration stations are identified by specifying the type, nominal flow rate and maximum working pressure.

SU-AD.R		X		X	Description
		10			10 000 Nm3/day
		15			15 000 Nm3/day
		20			20 000 Nm3/day
		24			24 000 Nm3/day
		39			39 000 Nm3/day
		60			60 000 Nm3/day
		96			96 000 Nm3/day
		156			156 000 Nm3/day
		240			240 000 Nm3/day
		480			480 000 Nm3/day
		720			720 000 Nm3/day
		960			960 000 Nm3/day
		1200			1 200 000 Nm3/day
		1440			1 440 000 Nm3/day
		1680			1 680 000 Nm3/day
		1920			1 920 000 Nm3/day
		2160			2 160 000 Nm3/day
		2400			2 400 000 Nm3/day
		4800			4 800 000 Nm3/day
		7200			7 200 000 Nm3/day
		9600			9 600 000 Nm3/day
		12000			12 000 000 Nm3/day
				06	PN6
				16	PN16
				25	PN25
				40	PN40
				64	PN64
				80	PN80
				100	PN100
				150	PN150
				250	PN250

For example, SU-AD.R 60 25 notation designates a dehydration unit of SU-AD.R type, nominal flow rate 60 thousands Nm3/day, maximum working pressure 25 bar.

The manufacturer reserves the right to make modifications without any prior notification.

CT Nr. 472 / 2011

TOTALGAZ INDUSTRIE
Nr. R.C.: J-22-3277/1994
CUI: RO6658553

IBAN: RO28BRDE240SV13842272400
B.R.D. G.S.G. Iaşi

Şos. Păcurari, nr. 128,
Iaşi, cod 700545, România
Tel. : 0040-232-216.391(2)
Fax : 0040-232-215.983
E-mail: office@totalgaz.ro
Web: www.totalgaz.ro

Certified management system