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Investigation of Gas Transportation in Main Pipelines

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Abstract

The separation of liquid and mechanical solid particles from the transported gas and their deposition in the relief depressions of the pipeline lead to a violation of the regularity of the flow, which is the reason for reducing the service life of the pipeline and process equipment. In addition, condensate and mechanical solid particles contained in the gas supplied to the enterprises of the processing industry create difficulties in the normal operation of the process equipment. To separate and collect condensate and solid mechanical particles during gas transportation, the direction of the gas flow into the collection tank is changed by installing a tank for collecting condensate at the beginning and end of the pipeline in the direction of flow and installing a triangle in front of the tank, then a knee based on the specific gravity and mechanical energy of the separated mechanical particles of solids and condensate collected from the gas flow into the tanks due to the difference in their weight.

Keywords: main pipeline, condensate, mechanical solid particles, filter, condensate collection tank, density, mechanical, kinetic and potential energy.

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Magistral boru kəmərlərində qazın nəqlinin araşdırılması

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Xülasə

Maye və mexaniki bərk hissəciklərin nəql olunan qazdan ayrılması və onların boru kəmərinin relyef girintilərində çökməsi axın qanunauyğunluğunun pozulmasına gətirib çıxarır ki, bu da boru kəmərinin və texnoloji avadanlıqların istismar müddətinin azalmasına səbəb olur. Bundan əlavə, istehsalat müəssisələrinə verilən qazın tərkibində olan kondensat və mexaniki bərk maddələr texnoloji avadanlıqların normal işləməsi zamanı çətinliklər yaradır. Qazın nəqli zamanı kondensatın və bərk mexaniki hissəciklərin ayrılması və yığılması üçün xüsusi çəkisi və mexaniki enerjisi əsasında boru kəmərinin əvvəlində və sonunda axın istiqaməti üzrə kondensat toplama çəninin quraşdırılması və tutumdan əvvəl üçluk, sonra dirsək quraşdırmaqla yığıcı tutuma gedən qaz axınının istiqaməti dəyişdirilir ayrılan mexaniki bərk və kondensat hissəcikləri çəki fərqlərinə görə qaz axınından tutumlara yığılır.

Açar sözlər: magistral boru kəməri, kondensat, mexaniki bərk hissəciklər, filtr, kondensat toplama çəni, sıxlıq, mexaniki, kinetik və potensial enerji.

Исследование транспортировки газа по магистральным газопроводам

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Аннотация

Разделение жидких и механических твердых частиц из транспортируемого газа и их осаждение в рельефных углублениях трубопровода приводят к нарушению регулярности потока, что является причиной уменьшения срока службы трубопровода и технологического оборудования. Кроме того, конденсат и механические твердые частицы, содержащиеся в газе, подаваемом на предприятия обрабатывающей промышленности, создают трудности при нормальной эксплуатации технологического оборудования. Для сепарации и сбора конденсата и твердых механических частиц при транспортировке газа направление потока газа в сборную емкость изменяют путем установки емкости для сбора конденсата в начале и в конце трубопровода по направлению потока и установки треугольника перед резервуаром, затем колена, основанного на удельном весе и механической энергии отделяющихся механических частиц твердого тела и конденсата, собираемых из газового потока в резервуары за счет разницы их веса.

Ключевые слова: магистральный трубопровод, конденсат, механические твердые частицы, фильтр, емкость для сбора конденсата, плотность, механическая, кинетическая и потенциальная энергии.

Introduction

Investigation of gas transportation in main pipelinesresult, the quantity of mechanical solid particles, such as moisture and dust, that are present in the gas that is provided to the user through the main gas pipeline occasionally exceeds the standard. In order to capture moisture and mechanical solid particles, filter separators are typically positioned at the end of the belt, and their performance is continuously tracked. There is a lot of labor involved in cleaning and replacing the separator's filter throughout the course of the day, and there is also a risk of environmental pollution and gas emissions up to the separator's nominal volume at operating pressure.

A portion of mechanical solid and condensate particles that have been separated during the transit of gas gather in depressions along the pipeline's terrain. As a result, the gas pipeline's throughput declines, hydraulic resistance pressure losses rise, flow irregularities, vibrations, and hydraulic shocks happen, and the pipeline's inner surface experiences increased corrosion and erosion. As a result, the gas pipeline is less durable and has a shorter lifespan. The operation of control measuring devices, automatic adjustment devices, and compressive compressors are negatively impacted by mechanical solid and condensate particles, which also increases errors in gas consumption measuring devices and decreases their reliability and durability [1]. Condensate and mechanical solid particles found in the gas supplied to major industrial firms make it more difficult to regulate technological operations and raise the possibility of equipment failure before its time.

Setting the issue

Research have revealed that compared to the end of the pipeline, the pressure of the gas flow is higher and the speed is lower near the entrance. In the depression zones of the pipelines, a portion of the condensate and solid particles are thus separated and gathered. Condensate and mechanical solid particles in the pipeline are removed more effectively because of the increased gas flow velocity near the belt's end. As the pressure gradually decreases throughout the pipeline's length, the liquid phase gradually evaporates, which causes the gas phase in the gas pipeline to become moist. A portion of the liquid phase in the gas pipeline transitions into the gas phase due to the rise in moisture content of gases under low pressure.

As a result of research, it was determined that As a result of research, it was determined that C_2; C_3; C_4; C_5; found in gases found in gases. In general, condensation occurs when the sum of the densities of the components is $\sum x > 1$, and condensation does not occur when $\sum x < 1$ [2].

Sour gases (H_2S and CO_2) in the gas significantly affect its thermodynamic parameters and ensure the maintenance of humidity in the gas phase [3].

Solution methods

According to the normative document "Main Pipeline Design Norms", it is recommended to install condensate collecting capacities in depressions of gas pipelines in order to check the presence of condensate and release it. In this instance, the number of condensate storage capacities likewise grows as a result of the pipeline's increased length. Only the liquid and solid particles that have settled at the bottom of the pipe are collected in the condensate storage tanks during installation; the majority of the liquid and solid particles continue to move with the gas flow due to the influence of aerodynamic forces.

Liquid and solid particles of mass m along the belt move with the gas flow at a speed v and have a kinetic energy of mv^2/2 [3]. Under normal conditions, the mass of the liquid (condensate) is ≈760kg/m^3, the mass of mechanical solid particles is ≈1200 kg/m^3, and the mass of the gas component is ≈0.8 kg/m^3.

The gas density at a given working pressure and temperature is determined by the following formula [4, 5]:

$$\rho_{work} = \frac{\rho_0 z_n T_n p_{work}}{p_n z_{work} T_{work}}$$

Right here $\rho_0 -$ the density of a gas under normal conditions, kg/m^3; $p_{work} -$ working pressure, MPa; $T_{work} -$ working temperature, K; $T_n -$ normal temperature, 293 K; $p_n -$ normal pressure, p_n =0.102 MPa; $z_n, z_{work} -$ are gas compressibility coefficients under normal and working conditions. The pressure of gas transported by main pipelines can be from 1.0 MPa to 9.0 MPa. When the working pressure is 1.0 MPa, the gas density is ≈8 kg/m^3; At 9.0 MPa, it is ≈70 kg/m^3.

In a short amount of time, the particles of the gas component, mechanical solid, and condensate all move through the pipeline's cross section at roughly the same rates, while having different masses, according to a comparison of the kinetic energy of the particles. The kinetic energy of mechanical solid and condensate particles will be greater than the kinetic energy of gas components because their mass is ten times more than that of gas components. Due to the differences in kinetic energy brought on by the weight of the particles, it is necessary to install a condensate collection capacity in the direction of the movement flow as a continuation of the pipeline in order to separate and collect the mechanical solids and condensate particles from the gas flow. By adding a tee and an end elbow to the belt before the cap, the gas flow is continued while the direction of the flow is changed. In this situation, the condensate storage capacity serves as a trap for both condensate and mechanical solids particles. Thus, mechanical solid particles of m_b mass and condensate particles of m_k mass moving with α acceleration will be separated from the gas components by m_ba and m_ka forces and thrown into the condensate storage capacity, and will sink to the bottom of the capacity due to m_bg and m_kg gravities. Aerodynamic forces are avoided and the separation of settled mechanical solid and condensate particles is guaranteed because the gas flow inside the tank is not moving.

The major gas pipeline's proposed technological layout is shown in Figure 1. Condensate collection capacity were placed in the beginning and end portions of the pipeline as a continuation of the pipeline in order to improve the quality indicators of the gas provided to the consumer. By adding a tee and then an elbow to the belt before the tanks, the gas flow's direction was adjusted.

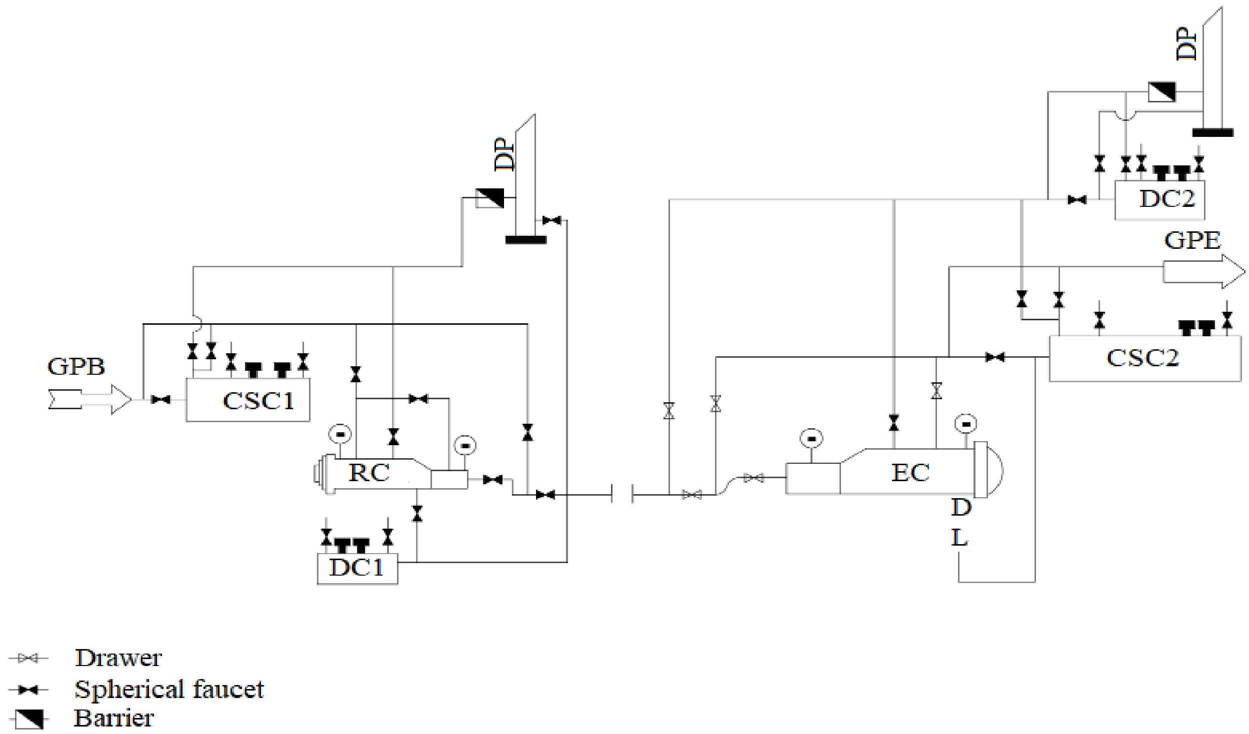

Figure 1 – The proposed technological scheme of the gas pipeline. GPB – the beginning of the gas pipeline; GPE - the end of the gas pipeline; CSC – condensate storage capacity; DC- drain capacity; RC - release chamber; EC - ersingabulu camera; DL - discharge line; DP – drilling pipe

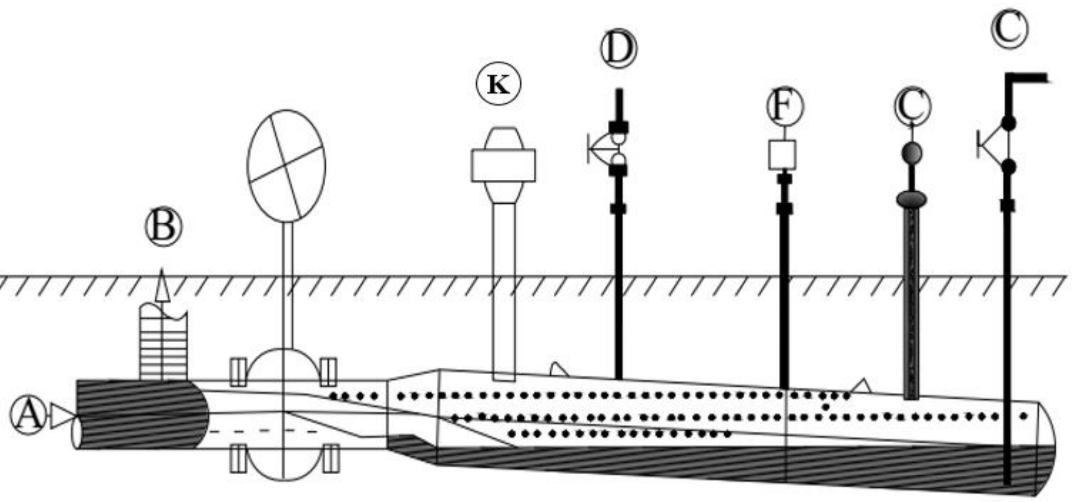

Figure 2 – The scheme of the capacitor. A – gas inlet; B – gas outlet; C – outlet of condensate (80 mm); Ç – reserve outlet of condensate (150 mm); D – reserve line (80 mm); F – output for the level indicator (80mm); K – protective valve for pressure relief of the tank

Discharge and intake chambers should be constructed after the condensate storage capacity at the beginning of the pipeline and before the condensate storage capacity at the end of the pipeline in order to remove accumulated condensate and mechanical particles in the interim segment. At various intervals, releasing the arse from the start should be done to clean the interior of the belt.

Figure 2 shows the diagram of the condenser capacity. In accordance with the requirements of the normative document "Safety rules for the operation of main gas pipelines", control-measuring devices, protective valves, appropriate connectors for emptying the capacity and removing condensate from the capacity are designed on the capacity. Due to gas pressure, condensate that has accumulated in the condensate storage capacity is collected and transferred to the prescribed location for disposal in a tank truck intended to transport oil products. Safety regulations as outlined in regulatory documents must be adhered to when collecting and transporting condensate from the tank. The tank's condensate must be drained throughout the day and in the absence of wind.

Conclusion

Condensate collection capacities must be installed at the beginning and end of pipelines in order to separate and collect mechanical solids and condensate particles from the gas stream due to differences in kinetic energy from the gas flow in order to improve the quality indicators of the gas supplied to the consumer.

The belt is extended by adding a triple, followed by an elbow, in front of the tanks. This changes the direction of the gas flow to the condensate collecting tank, causing mechanical solid and condensate particles to be separated from the gas flow and thrown into the tank due to their differences.

Conflict of Interests

The authors declare there is no conflicts of interests related to the publication of this article.

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