Patented installation for breaking foams in the natural gas fields

(Proven concept in the production fields in Romania)

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Introduction:

The installation was designed in order to address some practical challenges encountered in the gas production activity, especially as experienced in the natural gas mature fields.

In brief, the installation presented in the current papers is aimed to resolve the following problems:

- losses of pressure in the surface facility installation due to the presence of the foam under various forms (plugs, scattered, massive blocks)

- *Intrusion of the liquids and/or solids in the separation/dehydration/compressor units dragged in by the foam, with negative consequences in the performance of all the surface installation, from the wellhead to the field dehydration/compression station, even causing malfunctioning and interruptions.*
- *High energy specific consumption and materials are needed to treat the problem.*

As a result of gas reservoir depletion, the reservoir pressure and the well bottom hole pressure decreases below the critical values which do not allow for full and rhythmical evacuation of the fluids accumulated in the bottom hole. In order to maintain the wells in production, rhythmical evacuation of water along with the gas is required.

There are a number of methods available for bottom hole water removal, in order to maintain a clean (free) well.

One of the methods used for removal of accumulated fluids or having the tendency to accumulate (liquids and solids) is the periodical injection of soap agents, which foam the fluids inside the well casing through mechanical bubbling. Thus, the specific weight of the fluid column is significantly reduced, and easily lifted from the well at a lower reservoir pressure.

The physical characteristics of the foam created with this technology are not precisely known. What we know is that a foam "plug" is created, and this plug moves through the extraction pipelines and acts as a flexible solid (elastic body). The foam is produced, and then it reaches a critical point when the content of liquid is about 37% from the volume. At this point the bubble spheres are in fact in contact with each other(see Fig. 1).

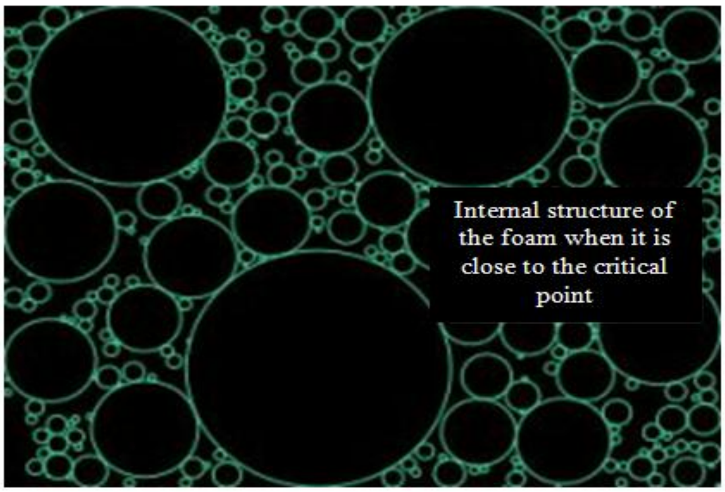

Fig. 1 Internal structure of the foam when it is close to the critical point

Further on, under the influence of the gravitational forces or other forces, the foam bubble membrane becomes thinner (one could see the liquid leaking through the membrane) until the equilibrium is reached. At this point the liquid phase from the foam reaches 5%.

Figure 2 shows the stratification of foam column: the lower part contains more liquid and the bubbles look like spheres and as you go up to the upper part of the foam plug the foam contains less liquid and the bubbles become polygonal shaped.

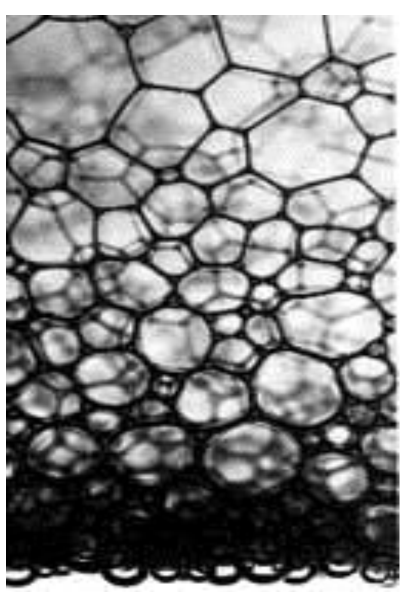

Fig. 2   Stratified structure of the foam mixture

It is quite difficult to retain and totally catch the foam produced on the surface separators, and the remaining foam leads to serious and complex problems along the entire technological flow, from the well cluster up to the interconnection with the transmission system (e.g. along the pipes, inside the dehydration stations, well head compressor, gathering group compressor, inside the pipelines, inside the pressure regulators, etc.).

This is why specialists looked for energy saving and for solutions to destabilize and break the foam, in order to turn the foam mixture into a new liquid stable phase, which could be easily and efficiently separated from the gas flux. In this respect antifoaming substances (foam breakers) are used, cancelling the effect of the foam.

In accordance with the energy saving approach, the new technology described below and illustrated in Fig. 3 constitutes the alternative solution for controlling the penetration of the foams from the gas extraction stream in the first segment of surface facilities, to avoid the negative technical, energetic and financial consequences along the whole gas gathering system.

The methodology *consists in mounting of the breaking foam equipment inside the surface facilities in different points of the surface facility architecture (pipes, separators, gathering group, etc)*

The equipment is designed to be compact, mounted through a couple of flanges in the interior of the pipeline, and can be used for a wide range of installation diameter, e.g. 4 inches to 8 inches.

The equipment introduces through adjustable chokes, variable quantities of antifoaming breaker agent in correlation with the foam volumes resulted from the well.

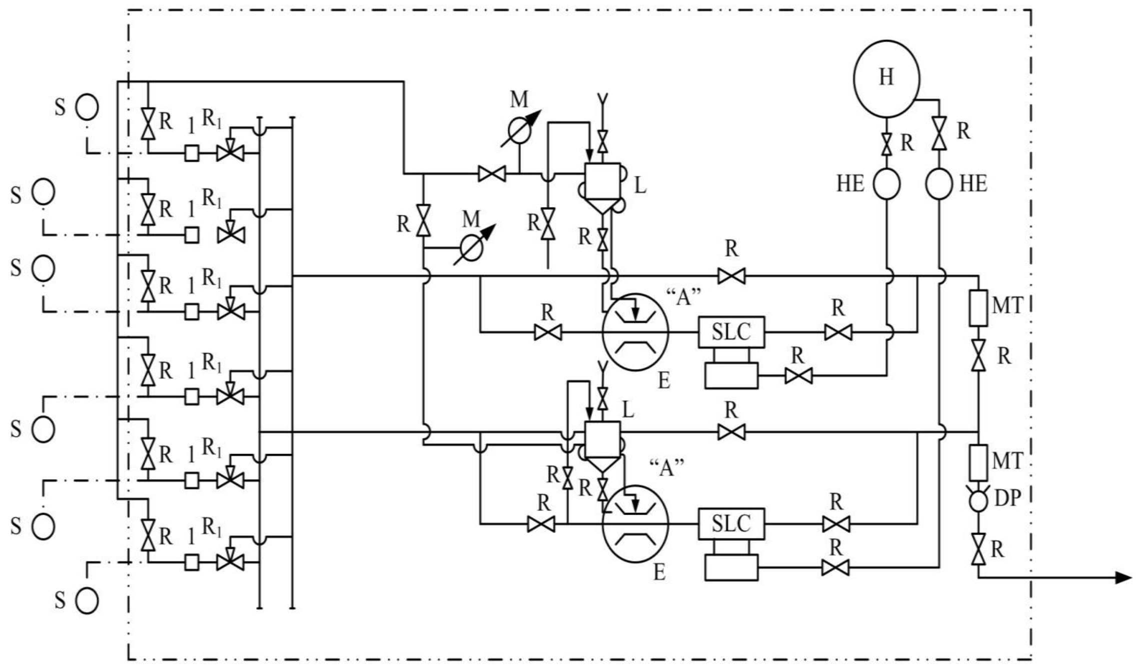

Fig. 3 – Proposed surface facilities flow diagram for a well cluster

S- well

1 - TPT (temperature, pressure and throttling device)

R1 – three way valve

2 – general collecting pipeline

3 – well rating collecting pipeline

R – closing valve

E – ejector

SLC – centrifugal separator

HE – rating tank

H – impurities tank

MT – orifice flow -meter installed on the general collecting pipeline

ME - orifice flow –meter installed on the well rating loop

DP - pressure discharge

Inside the device (see Fig. 4) a homogeneous mixture of antifoaming and foam is created, by pulverizing the antifoaming agent into the gas stream. Thus the foam is broken and the liquid is separated from the gas stream. The homogenous and deep contact between the antifoaming (introduced through pipe no. 5) and foam (flowing through pipe no. 1) mixture is obtained by means of an ejector (no. 4) which significantly raises, at local level, the gas flow speed, due to the "Coanda effect", and creates a turbulent flow. Control gas for the ejector (flowing through the pipe no. 3) which creates the “Coanda effect”, is supplied from the main gas stream (pipe no. 1), upstream the throttle effect where the gas flow temperature and pressure are higher than at the ejector inlet. In order to maintain the antifoaming agent at a constant level of temperature, the pipe for control gas is coiled around the antifoaming agent tank.

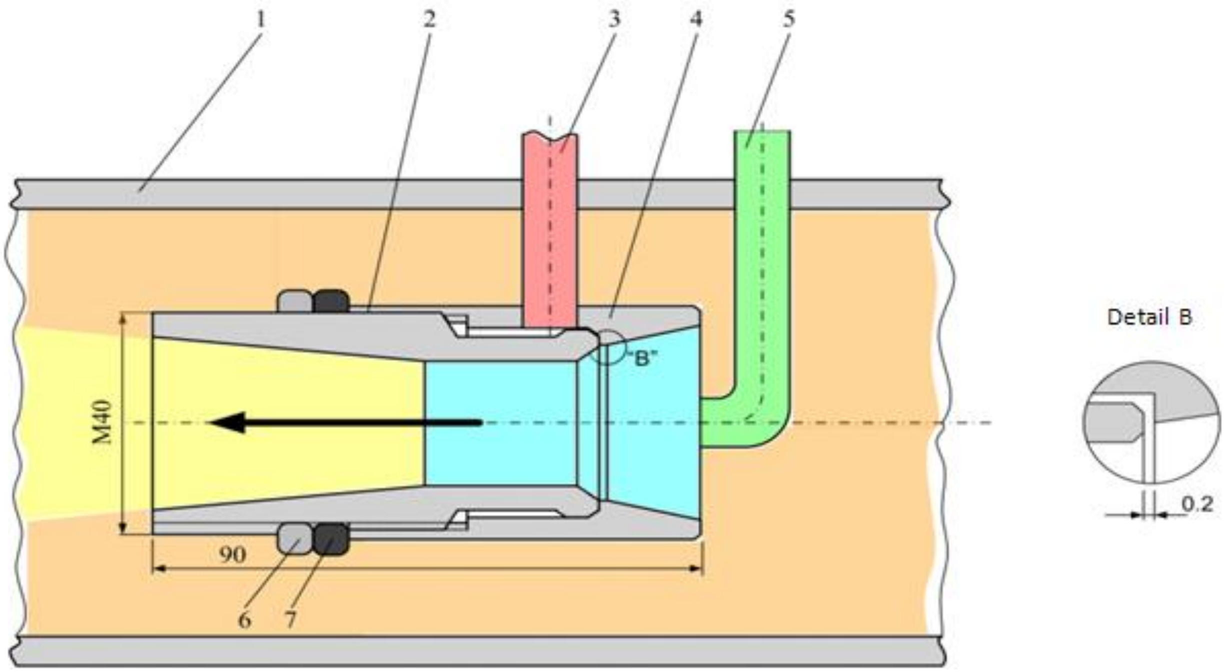

Figure 4 - Ejector

1.- Gas pipeline
2 – Diffuser
3 – Gas tap
4 – Nozzle
5 – Antifoam pipe
6 – Stop nut
7 – Tightening nut

In order to maintain the same production conditions of the wells, the throttling chokes have to be recalculated by taking into consideration also the choke for control gas which is installed before the throttling choke installed on the main gas flux.

This procedure was tested on a testing bench where the field production conditions can be reproduced, using the desired proportions of foam as in real conditions from various well clusters. The tests performed on the bench established the foam/antifoaming agent ratio, which breaks the foam at various gas flow speed (0-40 m/s).

The tests performed in the gas fields (under real operation conditions) showed that both the technique and the device worked successfully, the efficiency of device fulfilling the proposed target, no extra energy needed for the control of the new device and for the introduction of the antifoaming, keeping under control its viscosity.

The quantities of liquid retained and measured in the field were very close to the calculated quantities on theoretical grounds (determined on diagrams, correlations etc).
Results: The targeted effect is the neutralization and completely breaking of the foam, resulting permanent stable liquid which is efficiently separated by the surface facilities.

The energy consumed for the lubrication of the antifoaming/breaker installation is taken from the main stream gas pipe.

Installation has proven the above mentioned results by having been applied in pilot projects in several gas fields in Romania.

Achievements:

Energy savings and overall improvement of the natural gas production process.

Advantages:

- *No additional energy is needed, the installation is using energy from the production stream;*
- *Environmentally friendly: No additional or increase of noise or gas emissions;*
- *Minimum acquisition and operating costs for the installation, as well as easy and immediate mounting;*
- *Long functioning life, minimum wear due to static system;*
- *Highly recommended for mature fields.*

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Additional bibliography on this theme, by request:

1. Radu Gheorghe: *«Technique and device used in water removing in the gas extraction process»*;published in the Oil and Gas Monitor Romania, 2012
2. Radu Gheorghe, Costantin Eugeniu: *« Foam breaking technique and device used in the gas extraction process»;presented at various international conferences and local publications*