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RIGLESS JOBS IN GAS WELLS

1. INTRODUCTION

At the same time with gas reservoirs energetic depletion there appears the perforation zone deterioration or blockage issue given by wellbore zone reservoir parameters (clays), scale, completion fluid, soap precipitations, condensate, reservoir solids, salt etc. All these obstructions or blockages increase flow resistance in near wellbore zone. This resistance by flow results is an account of losing partial or total production capacity of the layer that imposes as immediate necessity of specific jobs applied by intervention to production restoration of flow conditions.

The Transylvanian natural gas reservoirs are not different from those mentioned above. An ambitious rehabilitation program has begun some years ago to the all major gas reservoirs in this area. This program consists in:

- remodeling geological model using special software's, in other cases obtaining information from 3D seismic, geophysical information from new wells;
- wells technical – geological programs (adding new perforations in the production area, partial isolations, recompletions, plug existing perforations and going up, deepening using cement milling or drilling, sidetrack etc);
- monitoring liquid loading issue by monitoring well production data;
- decreasing gathering pressure by implementing local compression;
- wellbore stimulation programs for skin factor reduction consist in:
  - mechanical cores analysis and data reinterpretation;
  - candidate wells hydrodynamic investigation (FGS, temperature log, build up test, isochronal test) and data correlation with production history;
  - where problems as perforation obstruction appear, there will be collected some samples from that zone and some lab tests will be done in order to find a solution to reduce or eliminate this obstruction form the perforation zone;

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- cleaning the perforation using the coil tubing;
- where we see serious problems, acid treatments are applied to the perforated zone and also through tubing reperforation.

For the efficiency of operation stimulation, it is important to know the type and length of the contaminated area in the layer.

2. SKIN FACTOR

The area near wellbore could have a different permeability from the rest of the area, which leads to the well production capacity change.

A.F. Everdingen considers that flow resistances in wellbore adjacent area or those resulting from well hydrodynamic imperfections produce the same effect for flow drop, which happens usually near wellbore. So near the wellbore it is a zone with a small thickness that needs an additional pressure drop of the fluids that goes through it. To name this area we use the term of skin effect.

All modifications of well production capacities are expressed by a dimensional coefficient called skin factor or pseudoskin (apparent skin).

Well factor or skin factor, (*s*), is an independent measure of time, it has a small expansion. Alteration or degradation of the wellbore transmisivity can be a damage if *s* is positive ($s > 0$) and *s* is negative ($s < 0$), in the stimulation case. The scope of any stimulation job is to reduce this factor or to make it negative.

This alteration is caused during drilling (mud filtrate invasion in layer), completion (casing, cement job, perforation) or can be caused by factors that affect the well during production, thanks of precipitation forming or migration by some very fine layer particles.

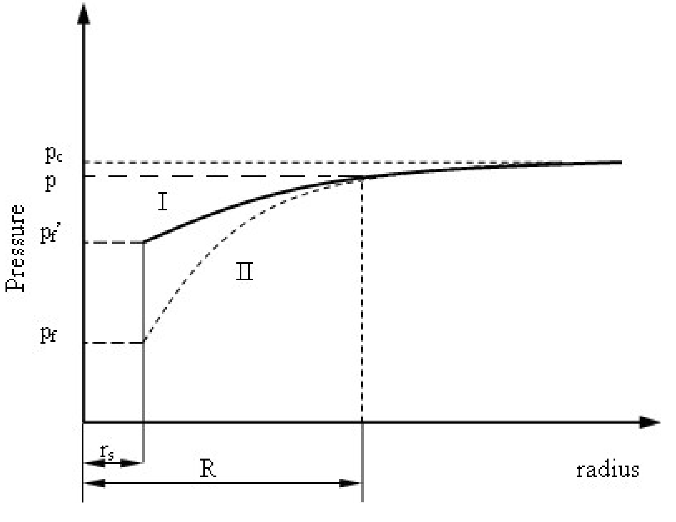

Fig. 1. Pressure vary in layer

If we made the pressure – well axis distance plot for the same permeability, k, then the layer pressure should vary by curve I in the whole zone. In case of a lower permeability existence, k_1, around wellbore ($k_1 < k$), within a radius R, the pressure should vary by curve II as shown in picture 1.

The supplementary pressure drop is $\Delta p_s = p_f' - p_f$. This supplementary pressure drop, proportional to the well flowrate is considered to be due skin effect.

3. RIGLESS STIMULATIONS JOBS IN PRODUCTION WELLS

In order to have a successful stimulation job it is necessary a deep knowledge of the reservoir lithology, mineralogical composition, reservoir and production parameters. The well must be analyzed and tested before stimulation.

If there are achieved all economical and technical objectives then a stimulation job is a success. The technical objective of the reservoirs stimulation jobs is to achieve a negligible or negative skin factor. The economical objective is achieved when reservoir fluid influx and well productivity is increased.

The stimulation job success could be evaluated only after a few production weeks or months, which follow the well cleaning and injected fluid recovering.

The most used methods of well stimulation with a rig or rigless are:

- reperforation,
- acidizing,
- hydraulic fracturing,
- combination between this methods.

Because of the workover operations risks and costs, the oil companies prefer as much as possible rigless jobs to accomplish well stimulation like reperforation or several coil tubing operations (acidizing, fracturing etc).

The scope of a reperforation job is to reopen or to create new communications canals between the well and the reservoir by passing the damaged area caused by mud or completion fluid. So the oil service companies have adapted to the oil production necessities and requirements to do underbalanced perforation or reperforation jobs at the producing wells using wireline blow out preventor (BOP). This type of jobs helps the reservoir to respond more quickly, improve flow conditions, by no longer losing fluid recovery time.

The scope of a coil tubing cleaning job is to wash the perforations by removing scale and other precipitates in the productive area. During the last decade, there were developed many coil tubing applications for reducing the working time, costs, but also because of existing technical conditions and restrictions in the well. In the beginning coil tubing was used especially to well liquid unloading (nitrogen kick off) and for perforation cleaning rigless. For a period of time, other applications are used for this unit like: underbalanced drilling, acidizing or hydraulic fracturing.

The scope of an acid job is to dissolve chemic with the help by a acid solution some deposits or scale that obstruct the perforation area or to dissolve a part of the reservoir matrix in order to increase the fluid afflux to the wellbore.

4. CASE STUDIES

In our rehabilitation programs for many gas reservoirs, our company accomplished successfully more stimulations jobs. As it follows, we will present a few stimulation jobs completed successfully by our company.

All these jobs were performed after a lot of analyses and hydrodynamic surveys.

4.1. Reperforation job

After an analysis and comparison of the production data and the reservoir parameters we have observed a poor production behavior for this well in comparison with their neighbors. So we decided to re-perforate it rigless with 2” trough tubing guns. After this job, we observed that the flowrate has doublet from 2 ksm/day to 4 kcm/day. Because we consider that this job was not a real success we decided to re-reperforate this well with 4” casing guns with deep penetration. After the re-repeforation job, we obtain a 11 ksm/day flowrate. In picture 2, we see the average daily production for this well and when we have accomplished the reperforation jobs.

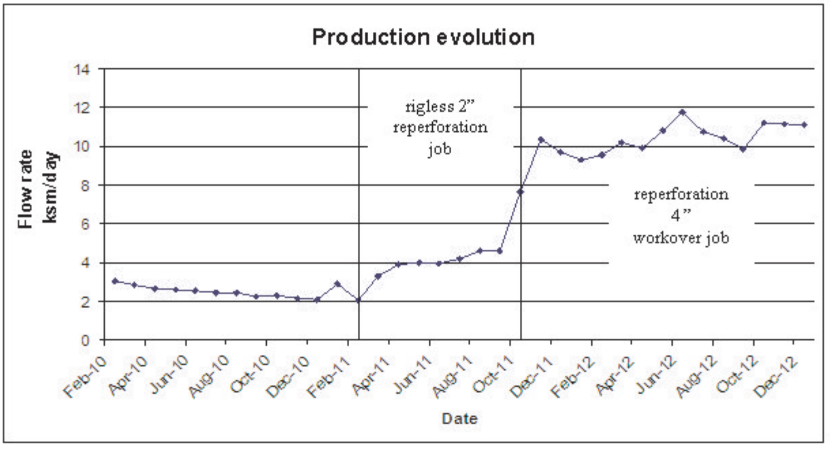

Fig. 2. Production evolution for a re-perforate well

Another rigless re-perforation job example is presented in picture 3. At this well, we observed, after a pressure build up test, that this reservoir has low permeability and porosity. So we decide to try to improve the flowrate by a rigless re-perforation job. The flowrate has increased from 12 kcm/day to 18 kcm/day.

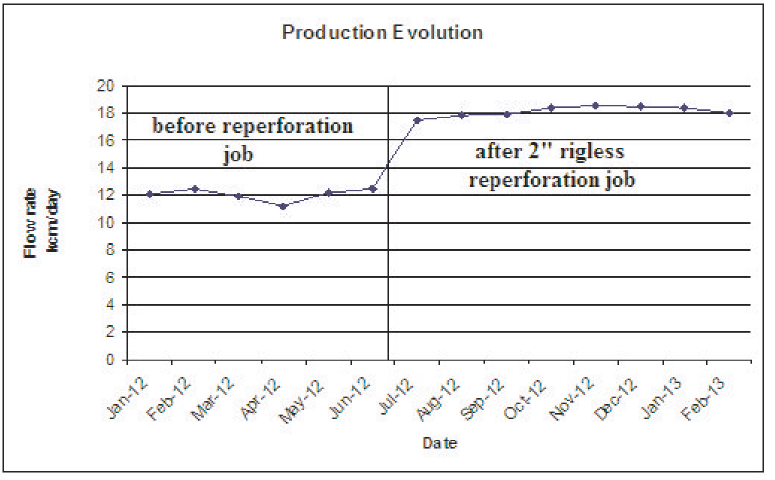

Fig. 3. Production evolution for a re-perforate well

4.2. Coil tubing perforation cleaning

We observed after a flow gradient survey (FGS) that the well has lots of perforation obstructed. We have decided that a coil tubing intervention for cleaning the well is needed. So there began a two days job, which consists in cleaning the debris and crusts from perforations using milling operation followed by nitrogen kick off. After a few days, we considered that this job was successful because the flowrate increased from 4 ksm/day to 10 ksm/day. The results are shown in picture 4.

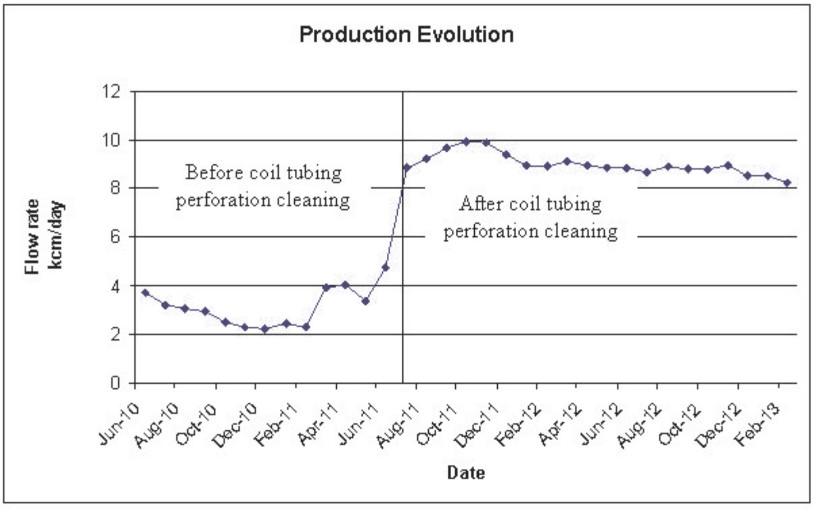

Fig. 4. Production evolution for a well cleaned by coil tubing

Another example is presented in picture 5. In this case after we cleaned the perforations blocked by sand deposits, the flowrate has increased from 20 kcm/day to 33 kcm/day.

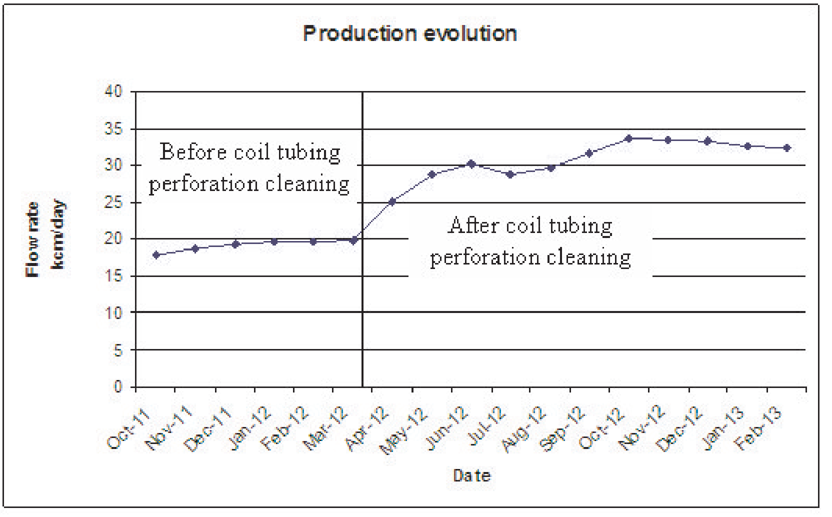

Fig. 5. Production evolution for a well cleaned by coil tubing

4.3. Acid wash jobs

For wells with rehabilitation programs which have a big production history and have recorded big cumulative, we propose to try some stimulation jobs to improve the flow parameters.

Several analyses and tests were made with various acid solutions on mechanical cores taken out from the productive zone.

Crusts, precipitates and other solids samples were taken from the workover wells but also from other wells from the productive area with a special wireline tool. These samples were tested with different acid solutions.

The conclusion was that a solution based on formic acid it is good for perforation zone cleaning if it does not generate precipitations that can obstruct the pores. After several lab tests which assure us that we will not damage the reservoir we made more tests in the production wells.

For example when we tested a productive well in this manner, the daily flowrate before acidisation was 26 kcm/day, after this being increased to 37 kcm/day. The production evolution is presented in picture 6.

In picture 7, there is represent the cash-flow results after the stimulation job which shows that this operation was a real success, the well amortized the investment made during 2 months.

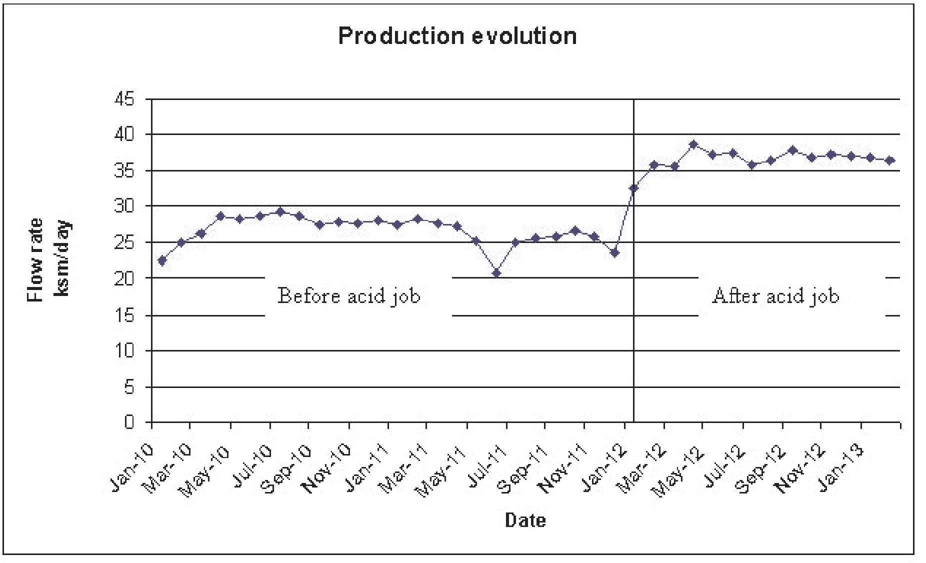

Fig. 6. Production evolution for an acidized well

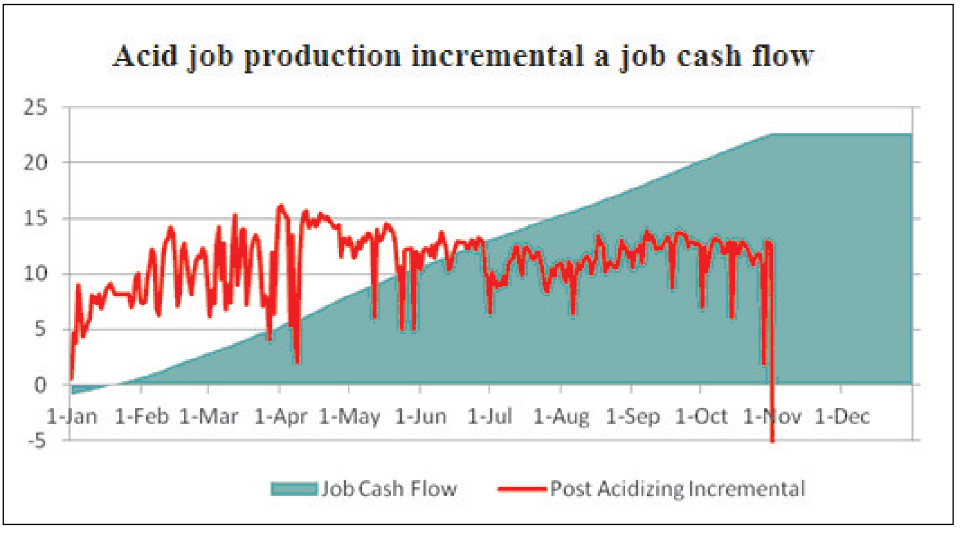

Fig. 7. Cash flow for an acid job

Another example is presented in picture 8. In this case after we had cleaned the perforations with acid, the flowrate increased from 20 kcm/day to 35 kcm/day. Same as in previous example, this was a very successful job where the amortization of the investment was made within 2 months. The results are shown in pictures 8 and 9.

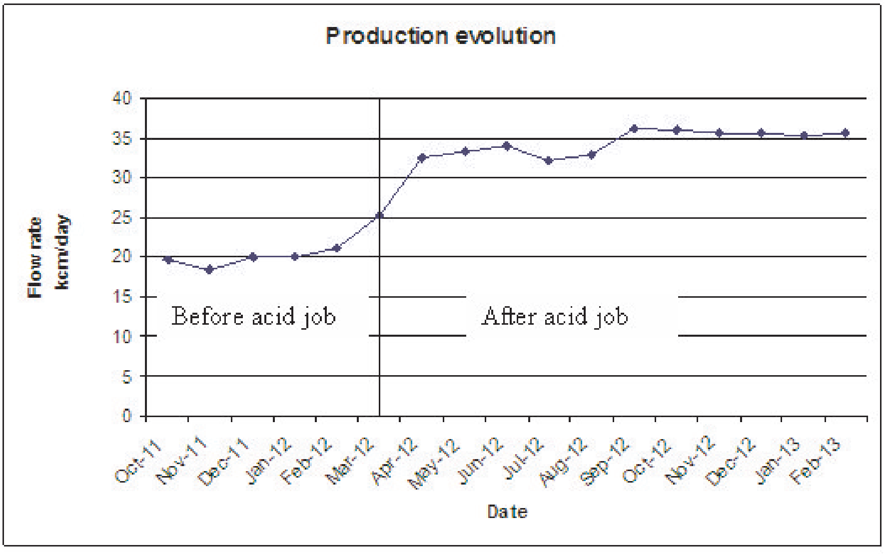

Fig. 8. Production evolution for an acidized well

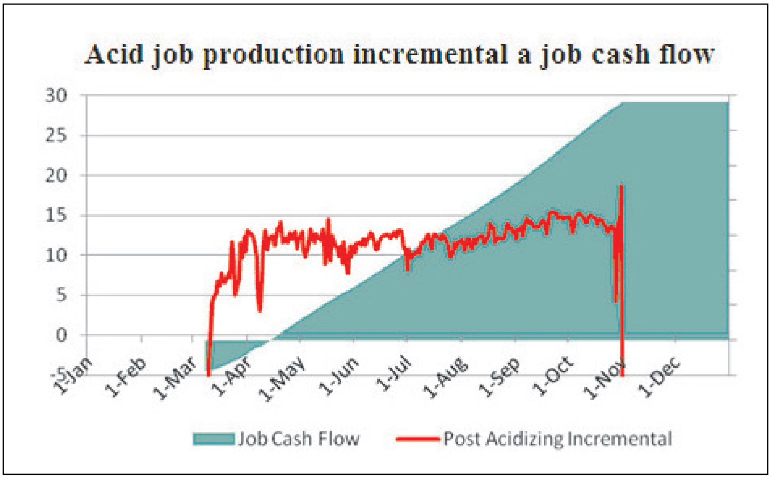

Fig. 9. Cash flow for an acid job

5. CONCLUSIONS

Although in the 50's, 70's and '80, it was the beginning of the well acidizing jobs at the wells that were in well tests or in workover, where the workover was a routine job, for us applying this coil tubing technology (rigless) is a real success.

In Transylvanian basin are several significant mature reservoirs. For this it is benefic to apply the rigless stimulation jobs to improve flow conditions by cleaning, reopening or generating new perforations.

In special at mature fields rigless stimulation it is welcome because in comparison with a workover is less expensive and most times it will accomplished underbalance.

Underbalance work at this reservoirs is capital because most times killing fluids will be recovered very hard, and the period of time for flow rate recovery before the workover can take months and involve high costs like nitrogen kick off, coil tubing jobs.

All this rigless stimulation jobs presented in the case study have been done in mature gas fields for maintaining or improving the production.

In mature fields before a re-perforation job or adding new perforations, we recommend if it is possible to run a saturation tool log.

As we can see, the rigless stimulation jobs doesn't present major risks for loosing a well, but in the most cases, they maintain or increase the production.

After several stimulation jobs, in which we obtain good results and successful performance, we will continue in the rehabilitation jobs of the gas fields using this kind of operations.

REFERENCES

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