ABANDONED WELLS AND MINES AS UNDERGROUND STORAGE FOR WASTE MANAGEMENT

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ABSTRACT. Albania is a rich country in oil, mineral and water sources as well as a very polluted one in Europe There are a lot of wastes that couldn't be managed in existing circumstances. At the present many oil and gas fields are in the third or depleted phase of the exploitation, while a lot of mines are abandoned. In this frame the paper presents some considerations to use them as underground storage for waste management.

Introduction.

Oil, gas and mineral industry is the most important one in Albania. The oil and gas fields are located in the Preadriatic region, which is very significative from the industrial, agricultural and especially tourist point of view. The technology of petroleum industry is very obsolete and agressive with regard to environmental pollution The environmental mining situation seems to be something better (in comparison with petroleum industry), but it is far away from European standards.

The petroleum industry strongly acts in all medium around: soil, surface waters, underground, etc. Consequently not only employs of this sector but also all the population and living things are subject to pollution effects. In most part of the oil field the crude oil is extracted with geological formation water in the form of water-emulsion which according existing "technological processes" is discharged freely. There are zones where the rate of discharged water-oil emulsions and drilling mud solutions is of 400 m^3/day and flow directly on the surface of earth, into brooks, rivers etc, even pollutes under ground waters etc.

There are same or analogous concerns in the mining and processing mineral sectors. Also different problems and concerns exist in and around the cities related to the waste pollution So, there are a lot of municipal wastes that could not be managed in dimp sites, or recovered, recycled, reintegrated etc. Of course all the mentioned concerns converge to the same point caused by a big lack of investment in the respective sectors.

A draft project program.

Taking into account that Albania is very rich in abandoned wells and mines as well as it is a country with many problems to environmental pollution and protection, the question raised is how to do use effectively this big underground capital for waste management in the frame of National Environmental Strategy.

For this reason a draft project program with the following objectives has been compiled:

- Developing of a strategy plan for waste management.

- Study of actual and perspective situation of the waste which could be managed using abandoned wells and mines.
- Study to present the existing situation of mines, selecting the most suitable ones, basing on different craters.
- Analyze the best opportunity, i.e. which optimally realizes the management of abandoned mines according to the waste quantities, qualities, etc. their constraints, logistics etc.
- Development of a pilot optimal project for the mines selected.
- Study to present the existing situation of abandoned wells from exploration and exploitation of oil and gas fields, selecting the most suitable ones according to the craters determined.
- A detailed analyze of the best opportunity of the selected wells.
- Development of a pilot optimal project for the wells selected.
- Recommendation for new juridical amendments in order to implement the studies mentioned above.
- Define and determine the different technical, financial, logistical etc. requirements of various technological waste proposed procedure, which industrially are going to be implemented in abandoned wells and mines, selected in according to the mentioned procedures.

The information System

The draft project program is anticipated on an information system containig :

- data resulting and coming from (in field) wells and mines, observations and investigations, laboratory analysis etc.
- information, built up from collection and analysis of the data sets.
- knowledge on the processes and phenomena's characterized wells, mines oil and gas fields etc. as they relate to geology, lythology, stratigraphy, geophyisics, hydrology, hydrogeology, rock mechanics, drilling, test analysis, reservoir engineering, mine designe and project, mineral technologies, mineral economics, management, mineral environment etc. Also in the information system is included the experience obtained by various specialists, technicians, experts etc. in the mentioned areas.

Several well from different oil and gas fields are shown in fig 1.

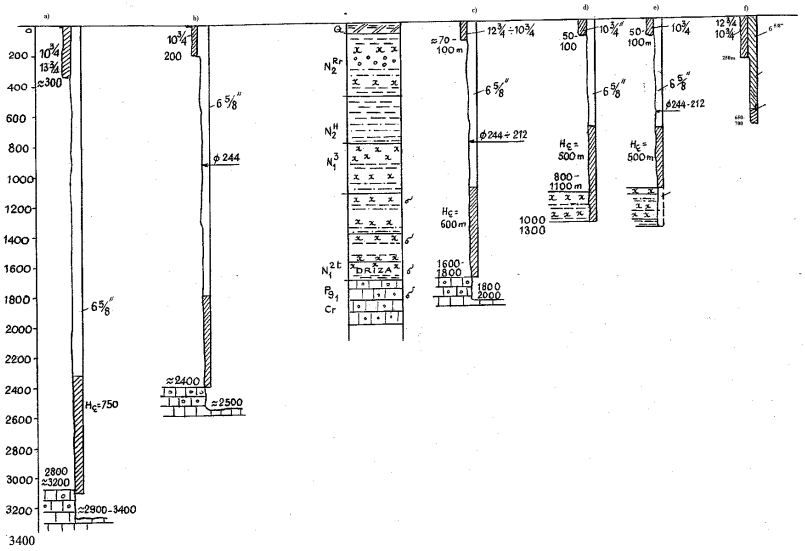

Fig 1

Several characteristics ofchromium, iron-nickel, cooper and coal mines are given below.

region	type	approx volume m^3	opening works	mining depth	mining method	rock stability	hydro-geological conditions	mine status
1 Mat	chromium	100000	horizontal	-200	opening spaces	high	abandoned	abandoned
2.Tropoje	chromium	30000	horizontal	-160	opening spaces	high	average	abandoned
3.Kukes	Chromium	130000	vertical horizontal	-230	openig spaces	average to high	average to good	abandoned
4.Librazhd	Chromium	150000	vertical	-250	opening spaces	low	difficult	efficient to abandoned
5.Librazhd	iron-nickels	500000	vertical horizontal	-220	filling spaces	average	difficult	conserved
6.Pogradec	iron nickels	150000	horizontal	-30-200	openig spaces	average to high	good	abandoned
7.Librazhd	iron nickel	100000	inclined horizont	-550	openig spaces	average to high	difficult	concerved
8.Mirdite	cooper	150000	horizont vertical	-200-300	filling spaces	low	good	abandoned
9.Puke	cooper	150000	horizontal	-150	filling spaces	low to average	good	conserved to abandoned
10 Mirdita	cooper	100000	horizontal	-150-200	filling spaces	low to average	good	?
11 Tirana	coal	200000	horizontal	-160	brocken spaces	average	good	closed

Optimal Safety Problem

Discussing about the benefit of the using of abandoned wells and mines, an important question could be raised: is it possible to define a optimal safety problem?, if yes, its solution would be deterministic or risky (random) etc. These questions are related to a big issue which would only principally be disscusseed in this paper.

The main safety goal of a petroleum and mining company is that its activity shall not cause accident and losses or in other words:

- loss or injury of human life
- damage of the environment
- significant loss of material assets , production etc.

But how to include these factors into a safety problem?

The safety goals. The mentioned goals express an ideal safety level, even that they do not constitute a useful tool from managerial point of view. Why? Because these parameters are not the quantified ones, consequently "their minimization" has not sense. On this situation this small contradiction could be eliminated whether these factors could be evaluated by monetary terms, say in U$D. For example, if the loss of personal injury are to be evaluated by loss of works expressed in U$D, the damage of environment by units of surface damaged in U$D too etc., then is possible to estimate all the respective losses in the monetary tools. This is the first step in the formulation of the safety problem included into a given strategy.

The technical-economical parameters Generally say to implement a safety strategy in practice the allocation of investments, assets, capitals, materials, energy, labor etc. are needed. In this frame to define a specific safety problem need to need to be done the mentioned (or/and other) functions which could depend on one ore more variables. For example in the case of abandoned wells this function can depend on the time considered, number of wells etc.

The constraints. Defining a specific safety problem related to abandoned wells and mines several constraints could enter in. Those may have different forms as equalities, inequalities, equations etc. Independently of theirs form, the constraints limits the solution's zone of the safe problem considered.

The criteria's. There are different criteria's as NPV (Net Present Value), DPR (Discount Profit to Investment), GGR (Growth Rate of Return) to estimate the worth of a study. The criteria's, which can depend on one or more variables are deterministic or random ones, in other words the safety problem would be studied in two situations: without or/and with risk. Thus two types of models are available.

The first may be formulated under the hipothesis that all inputs (capital cost, operating cost, discount factor, taxes etc.) are deterministic ones. To obtain the optimum of NPV different numerical and analytical methods (as Lagrange Multipliers, Njyton - Raphson etc.) can be applied.

The second is a Risk Analysis model (based on Monte Carlo techniques) in which at least several variables are random. It is to be emphasized that this model can also include the deterministic variables.

Independently of the model used without or/and with risk using abandoned wells and mines all alternatives should be compared between them in order to determine the best one. Of course the next also is compared with the versions emanated by other considerations. (for example the technologies which prevent the escape of oil and gas into water ways and atmosphere in the case of oil fields, the technologies which anticipate the dump sites etc., etc.).

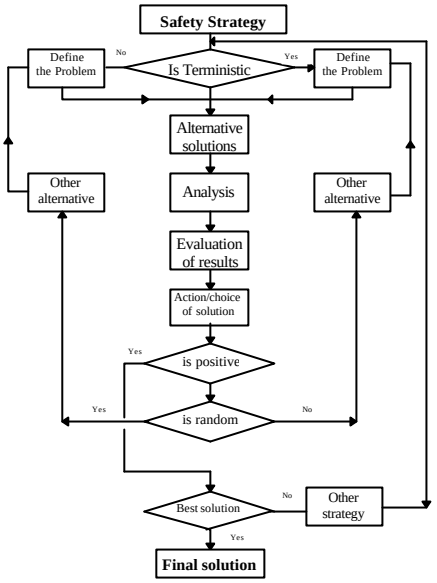

Fig. 2. Safety strategy

Preliminary considerations on implementation procedures.

From the managerial point of view the issue of abandoned wells and mines as an underground storage for waste management is a multidimensinally problem which encompasses many components such as political, legal, engineering, economical, financial, social, environmental etc. Of course each component represents a specific question that could and should be treated in details and included in the respective reports, pilot project etc.

Between them we mention: selection of wells and mines based on an adequate political support, national waste strategy, legal framework etc.; classification of wastes according to theirs properties and characteristics; determination of technological procedures, technical tools, infrastructures, logistics etc. which effectively grantee the success of the respective studies and projects

For example let's consider the injection of the waste streams containing oils-water, hydrocarbons, water mixtures, emulsions into the wells. Under the hypothesis the technology is determined, it is indispensable to know: the layer geology, rock properties and fluids contained, energy characteristics and theirs mechanisms, well equipment, surface installations, infrastructure and logistic (transportation and injection system), log and well test analysis, low of fluids flow and their solutions (analytical, numerical etc.), etc., etc. In the fig. (5) a numerical solution is shown, obtained by a well injection simulation using a simple model with the following characteristics:

model length	*= 100 m ;*	*filtration section*	*= 40 m^2;*
absolute permeability	*= 10^{-12} m^2 ;*	*porosity*	*= 0.20;*
emulsion viscosity	*= 1 Mpasec ;*	*oil viscosity*	*= 6 Mpasec.*

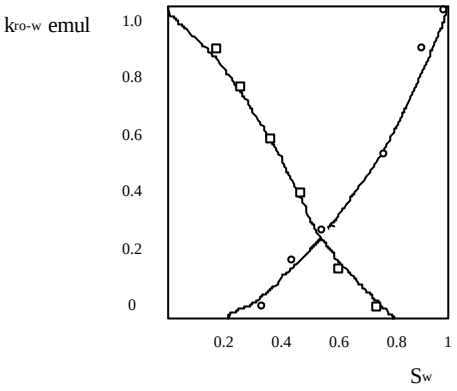

Fig. 3. Relative permeabilities

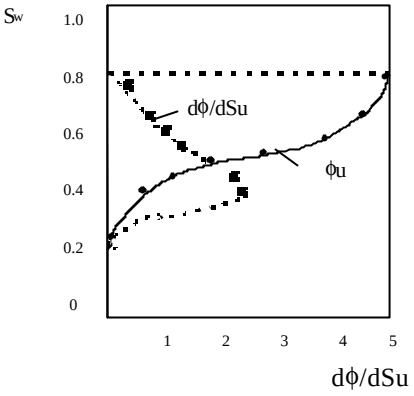

Fig. 4. ϕ_w and $\frac{df_w}{dS_w}$ Functions

The relative permeability graphs are given as in fig. (3), water functions fig. (4) while the saturation profiles after the injection periods of time t_1= 146 days, t_2=292 days, t_3=438 days in fig. (5).

Also in fig. (6) the graph of the injection pressure obtained in a well of the Visoka oil field is given.

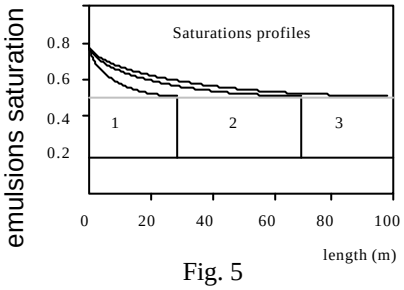

Fig. 5

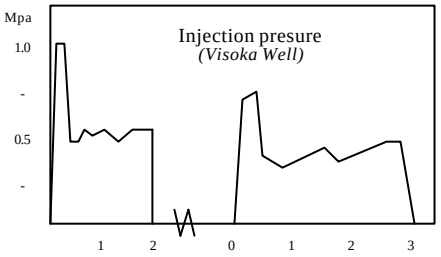

Fig. 6

Conclusions

- The great number of abandoned wells and mines is a capital that could and should put into efficiency for waste management.

  The most part of wells in on-shore from:
  - depleted gas fields
  - oil fields (sandstones and limestones)

should be investigated and used in the next future for
- industrial gas underground storage (gas depleted structures)
- waste management (there are carbonated field and wells into which the waste streams could be injected under a very small injection pressure (or without), annular reinjection of drilling wastes can be used in exploration wells in the Adriatic sea etc.)
- exploitation of water resources placed in nonperfored layers of abandoned wells.

The abandoned mines offer a temporary possibility as underground storage for municipal and industrial waste management.

- The safety problem, using abandoned mines and wells could be optimized in a deterministic way or/and random one applying Risk Analysis and Monte Carlo techniques.

- New amendments are indispensable in order to use industrially abandoned mines and well as underground storage for waste management, according to the respective pilot projects.

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