Available online at
http://journals.usamvcluj.ro/index.php/promediu

ProEnvironment

ProEnvironment 7 (2014) 132 - 136

Original Article

Inventory of Processes and Raw Materials Used in the Processing of Drilling Mud Resulted From Natural Gas Extraction, in the Ogra Waste Deposit

OTGON Maria Claudia, Tiberiu RUSU*, Andrei Tudor RUSU, Călin Ovidiu SAFIRESCU

Technical University, Memmorandumului St.., No. 28, 400114 Cluj-Napoca, Romania

Received 14 July 2014; received and revised form 20 August 2 014; accepted 29 August 2014
Available online 23 September 2014

Abstract

The paper deals with a modern drilling mud processing technology resulted following the extraction of natural gas, found in the Ogra waste deposit, in Mures county. The method of treatment of these wastes involves using a specific recipe which insures a minimal impact on the environment. Depending on the physical and chemical properties of the drilling mud, its aggressiveness towards water and soil can be established. The paper characterizes the processing method through the recovery of these wastes and presents proposals for reducing environmental risks.
Keywords: chemicals, waste, method, drilling mud, treatment.

1. Introduction

The specific extraction waste deposit of Ogra, Mures county, has a surface of approx. 2 ha [4], being located outside the settlement of Ogra in Mures county (fig.1). The site is situated at approx. 800 m from the river Mures and approx. 350 m of the river Lăscud.

2. Material and Method

In November 2013 the inventory of used processes in the Ogra waste deposit has been made. The main activities for processing the wastes generated through natural gas extraction at the Ogra waste deposit are shown in table 1 [1, 2, 3, 5].

The technological flow for specific waste treatment through final depositing is as follows [7]:

- the retaining of the petroleum products layer from the deposited wastes surface through spilling through the overflow situated at the limit between the two intermediary deposits;
- the transfer of detritus and the drilling waste in equal quantities in the preparation tank;
- the moisturing of detritus with drilling fluid and the homogenization of the mixture;
- the establishing of the mixture volume on the basis of a water gauge of the tank (volume according to the level of the mixture in the tank);
- the calculation of the solid NaOH, 100% active substance;
- the preparation of NaOH solution (1 kg of NaOH to 5 l of water) and the addition of NaOH solution in the preparation tank;
- the homogenization of the mositured detritus with the waste fluid and the NaOH solution;

* Corresponding author.
Tel: +40-264-401727
Fax: +40-264-401727
e-mail: Tiberiu.Rusu@imadd.utcluj.ro

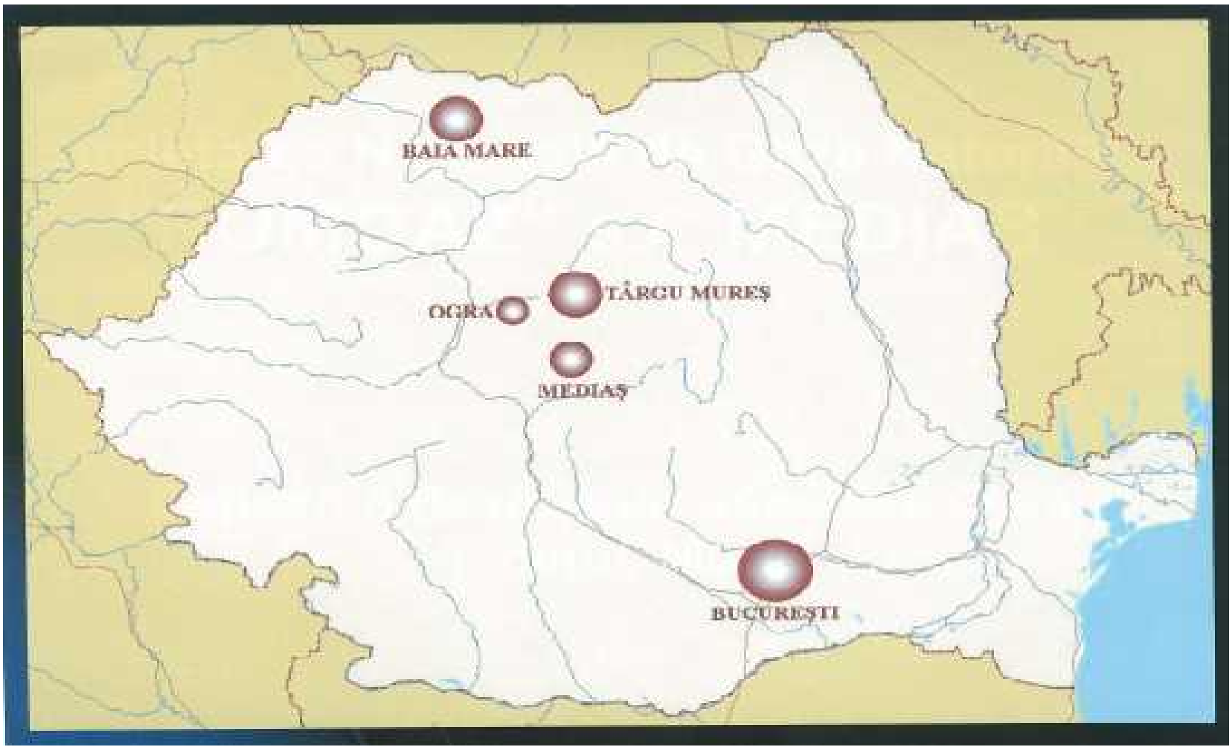

Figure 1. Location of the specific waste deposit – Ogra, Mures county

- the calculation of the necessary cement quantity according to the volume of mixture established before;
- the addition of the cement dust according to the established volume of mixture;
- homogenization of the mixture;
- the determination of the workability with the help of the spreading cone: if the spread has a diameter larger than 110 mm, extra cement dust is added and is homogenized; if the spread is less than 110 mm, the mixture is loaded in the truck and is transported in cell 1 of the final deposit;
- the mixture is basculated in metallic forms;
- after the mixture is hardened the forms are removed;
- after each batch the mixture tank is washed.

2.1. Selection of raw materials

The selection of prime materials was made regarding economic, technologic and environmental criteria. The treatment of wastes includes the use of cement, plaster and NaOH [8].

The auxiliary prime materials are: water (rainwater), methane gas, small quantities of electricity and the diesel necessary for the equipment. The chemical substances used in the technological flow are the ones determined in the treatment process.

All substances and chemical products used in the technological process are acquired from authorized suppliers, only if accompanied by safety data sheets and deposited in adequate spaces, according to SDS requirements.

During the activity for which authorization is claimed no dangerous substances included in SEVESO III Directive are used.

The main materials used in the process are described in table 2, which contains their environmental impact and alternative materials are presented where applicable.

The raw materials used have been selected according to economic, technologic and environmental protection factors. The principal of treating the wastes by solidification is found in BREF for petroleum and natural gas refineries [10], chapter 4 – Techniques to be considered in the determination of BAT, 4.25.6 -.

2.2. Processing the wastes in order to stabilize them

►from the intermediary depositing tanks, with the help of a cup excavator, equal proportions of detritus and drilling fluid are transfers in the preparation tank (the necessary quantity for a processing batch, i.e. – 20 + 20 - m^3);

Table 1. Inventory of processes used for specific waste treatment, Ogra deposit

Process	Comments	Maximum capacity
Receiving the drilling waste and detritus	Visual control, weighting of the waste, comparing data with written receipts, unloaded wastes control	-
Storage in intermediate deposit	Unloading of drilling mud wastes in the tank dedicated to storing drilling fluids and unloading detritus in the tank dedicated to detritus	200 m^3 for detritus; 600 m^3 for drilling fluid
Separation of oils and petroleum products	Through an overflow positioned at the limit of the two intermediary tanks, the petroleum products are being discharged in a pipe having a diameter of 200 mm, from which they fall in the entrance chamber of the separator, where the gross and fine separation of oils and petroleum products takes place.	125 m^3
Chemical treatment with cement, plaster, NaOH, for solidification	From the intermediate tanks, with the help of an excavator the detritus and drilling mud is transferred in equal waste quantities, over which the following are added, according to the recipe: - Cement and plaster (for 1 m^3 of drill mud and detritus mixture 112.5 kg cement and 42.5 kg plaster are added -Or cement and NaOH (for 1 m^3 of drilling mud and detritus, 200 kg cement and 1 kg NaOH are added)	83 m^3
Transport of the paste to final deposit	Carried out with trucks towards cell 1	
Final deposit	The paste obtained through cementing is deposited in compartment I, and at exhaustion, in compartment II. The wastes identified by the codes: 19 09 02 and 19 02 06 are deposited without treatment in cell I, and at exhaustion in cell II.	Compartment I =96.800 m^3; Compartment II= 7.840 m^3
Water draining	The draining of water from cell I is accomplished through draining tubes with a diameter of 200 mm; this reaches the visiting chamber in cell II, from which it ends up in the collection shaft, from where it is sent to the petroleum products separator by means of a submerged pump.	Collection shaft - 70m^3
Leachate collection	The leachate in compartment II is collected in the shaft located in the western part of the cell. This is fitted with a submerged pump which evacuates the leachate in the entrance chamber of the petroleum products separator	-
The supply with prime materials necessary for the treatment	It is accomplished on order through transport with lorries and is deposited in a closed barrack.	-

► the necessary quantity of 6 tons of cement is added as well as the sodium hydroxide solution prepared from 40 kg NaOH and 200 l water; the water necessary for the mixture is pumped from the collection shaft of compartment 1, situated in the final deposit section;

► the mixture is homogenized with the help of a frontal loader;

► the homogenized mixture is transported by tipper truck in compartment 1 and it is cast in metallic casings in order to form inert waste blocks;

The waste processing to reach stabilization is done according to the recipe:

- 1 m^3 waste (drilling fluid and detritus in equal measures);
- 200 kg cement;
- 1 kg NaOH. or
- 1 m^3 waste (drilling fluid and detritus in equal measures);
- 112.5 kg cement;
- 42.5 kg plaster.

The specific wastes wich are accepted on the establishment are: drilling fluid wastes (fluid with a density between 1.12 - 1.20 t/m^3) and detritus (semisolid consistency with a density between 1.8 - 2.0 t/m^3), resulted from the process of natural gas extraction.

Table 2.Raw materials

Raw material used	Chemical nature	Quantity /year (qualitative and quantitative)	Percentage (1) % in product (2) % in surface water (3) % in sewage (4) % in waste (5) % in soil (6) % in air	Environmental impact	Adequate alternative if there is significant potential for environmental impact	Methods of receiving, depositing, possibility of significant risk for the ones with environmental impact
Cement	inorganic, dust, R41; R38; R43 (Xi)	200 kg/1 m^3 processed waste	100 % in waste. Not dangerous in stable form included in the deposited paste.	No risks identified	No significant impact	Stored in storage barrack (A)
Sodium hydroxide (NaOH)	inorganic, strong base R35	1kg/1 m^3 processed waste	100 % in waste, not dangerous in stable form included in the deposited paste.	LD 50/oral-rabbit 500 mg/kg LD 50/dermal-rabbit 1350 mg/kg LD 50/ip*-rat 40 mg /kg *intra-peritoneal	No significant impact	Stored in storage barrack (A)
Plaster ($CaSO_4$)	inorganic, salt	42,5 kg/1 m^3 processed waste	100 % in waste, not dangerous in stable form included in the deposited paste.	No risks identified	No significant impact	Stored in storage barrack (A)

2.3. Treatment methods of specific wastes

The process of stabilization/solidification of wastes. Solidification is a process in which materials are added to the wastes in order to solidify them. It can be a solidification agent which either physically surrounds the contaminant, for example cement or lime, or which uses a process of chemical fixation. The resulting waste usually forms a solid substance easily manageable (with a reduce percolation).

According to BREF- The reference document regarding the best available techniques in petroleum and natural gas refineries – 2003, the environmental benefits achieved through the solidification process are: the improvement of waste handling and their physical characteristics, the diminishing of the surface on which pollutants can leak as well as the lowering of solubility for dangerous compounds (metals in the treated wastes are transformed in less soluble forms). The applicability of the processes based on cement: they have a great efficiency when the wastes contain metals because, due to a high level of pH in the cement mixture, most compounds are transformed in insoluble metallic hydroxides; the presence of organic impurities can act as an agent which interferes with the period of cement hardening and it limits the possibility of this way of elimination. The reference document BREF [6] for petroleum and natural gas refineries states in chapter 4 – Techniques to be considered in determining BAT, point 4.15.7 – Waste depositing: the wastes which are to be eliminated must be deposited in an environmentally friendly way, approved by the competent environmental protection authority. The depositing must not create secondary environmental problems such as smells or groundwater pollution resulting from the percolation of running surface waters from the establishment. The Ogra deposit is in conformity with the best available techniques in the domain, thus the intermediary deposit with a volume of 883 m^3 consists of [8]:

• tank for detritus with a volume of 200m^3, is a rectangular, buried structure. In this tank the transported detritus' decantation takes place

• the tank for drilling fluid wastes, with a volume of 600 m^3, is a rectangular, buried structure.

On the wall separating it from the preparation tank there are 3 pipes with a diameter of 200 mm and dosing tubs, through which the access of used drilling fluid is assured in the preparation tank.

In addition, the preparation (processing) tank with a volume of about 83 m^3 is a rectangular, buried concrete structure. In this tank, the processing of wastes for the final deposit takes place. BAT conclusions [6] according to reference document BREF for petroleum and natural gas refineries, chapter 5: According to BREF - Reference Document on Best Available Techniques on Waste TreatmentsIndustries – August 2006 – (cap. 4.3.2.4. - Solidification as a method of treating the wastes by de-cementation process ensures the incorporation of dangerous or non-dangerous compounds from the waste composition in the cement mass. The method does not require the use of special equipment. The techniques of mixture and cementing are already well known). The use of solidification is also specified in chapter 5: The Best Available Techniques, being mentioned in BAT conclusions for the physic-chemical treatment of solid wastes [9]. The depositing of wastes solidified by cementing can be done in surface deposits or in underground mines. In some countries the paste resulted from cementing is used as a covering material for closing abandoned salt mines.

3. Results and Discussions

Analyzing the processes' inventory as well as the methods and recipes used for treating the drilling muds in the specific wastes deposit of Ogra, the following environmental benefits are identified:

►Through this physic-chemical method of waste treatment, the metals within the treated wastes are transformed in less soluble forms (hydroxides and metallic carbonates);

►The transport of the paste resulted from solidification can be done with no special equipment;

►The migration of metals from the solidified product is considered unlikely;

►The treated waste can be used as coverage material for closing the mines, fillings for roads, bridge consolidation, auxiliary materials in construction, etc.

4. Conclusions

By using the Ogra method of processing the wastes resulting from natural gas extraction, a treatment of the above mentioned wastes is ensured, so that the wastes classified as dangerous to become non-dangerous and their final depositing ensures the reduction of environmental pollution risks.

Acknowledgments

This paper was written with the help of S.N.G.N Romgaz S.A. Medias and of Prof. Dr. Eng. Tiberiu Rusu, Technical University of Cluj-Napoca.

References

[1] Ana I., 1986, Drilling fluids and cements [Fluide de foraj şi cimenturi] – I.C.P.P.G., Câmpina.

[2] Gavrilescu E., 2007, Sources of pollution and pollutants of the environment agents [Surse de poluare si agenti poluanti ai mediului] – Editura Sitech.

[3] Giurgiu Gh., 1984, Driller's book extract [Cartea sondorului de extracţie] –Editura Tehnică, Bucureşti.

[4] Ştefănescu D., 1998, The practice of extracting natural gas [Practica extracţiei gazelor naturale] - vol.II, Editura Universităţii Lucian Blaga.

[5] Ştefănescu I., Varvara I., 1998, The impact of exploration and mining drilling for natural gas on the environment in the basin of Transylvania [Impactul forajelor de explorare şi exploatare pentru gaz metan asupra mediului, în Bazinul Transilvaniei]- Revista minelor.

[6] Rossiter H.M.A., P.A. Owusu, E. Awuah, A.M.MacDonald, A.I. Schäfer, 2010, Chemical drinking water quality: Water costs and scope for advanced treatment, Science of the Total Environment 408, 2378–2386.

[7] ****, 2012, National gas magazine [Revista natională de gaze natural], nr.2, octombrie, 2012- Impact of water leachant on the environment [Impactul apei de zăcământ asupra mediului].

[8]****, 2013, www.labsmn.pub.ro/projects/media/cd/5 /4/.htm.

[9] ***, 2013, Documentaţia de mediu a sondelor de explorare şi exploatare din cadrul SNGN ROMGAZ SA, 2013, nepublicata.

[10] ***, 2014, U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance, Profile of the Oil and Gas Extraction Industry Sector Notebook, Chapter 5, Pollution Prevention Opportunities.