OVERVIEW ON THE IMPLEMENTATION OF TREE TEST METHODS FOR CONFORMITY ASSESSMENT OF FLUIDS

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ABSTRACT
This paper presents three test methods for conformity assessment of technical fluids, all included in international, European and Romanian standards and their relevance for work security and health.

KEYWORDS: Conformity assessment, fluid tests.

1. TESTING STANDARDS FOR DETERMINING SOME FLUID PROPERTIES REQUIRED BY AN EUROPEAN DIRECTIVE

The appropriate utilisation of the technical fluids, optimally designed and selected for solving actual and concrete problems, may lead to an economy of billions of dollars in the developed countries, saving energy, reducing wear, reducing the expenses for technical maintenance and increasing the exploitation periods of machines and equipment.

In the traditional research centers, either academic or industrial, researches related to the properties and characteristics of the technical fluids, especially hydraulic ones that could be involved in the security of mining industries are developed [3, 13, 15]. These researches have contributed to improve the health protection and the security of the mining workers [13], the general problem of the security involving both a component related to the infrastructure and a human one.

1.1. The European Directive 92/104/CEE

The specialists but also the administrative bodies debate the real problems related to the presence of the dangerous substances in the working environments and the methods of reducing the professional risks [2, 3, 4, 13]. A first result is desired to have the consciousness of the risks associated to the dangerous substances, than promoting activities that reduce these risks and offering solutions for best available practices. An interesting subject is the potential and the expectations of some materials and in this category may be included the technical fluids as they could increase the potential risk under certain conditions of exploitation that could accidentally occur.

It is for these reasons that the necessity of specific regulations occurs in the field of conformity assessment [14] for these types of products in relation to the technical prescriptions, a demand that may be included as a component of a sustainable development for the mining industry [13]. In the European Union, the Article 118a of the Treaty provides that the Council shall adopt, by means of Directives, minimum requirements for encouraging improvements, especially in the working environment, to guarantee a better level of protection of the safety and health of workers.

Taking into account the risks associated to the dangerous substances, the flammability on hot surfaces as a property of the technical fluids become more and more investigated [5, 7, 9] and related to actual applications, as this event of fluid leaking on hot surfaces (if it is happening) could lead to fire, self ignition and explosion. The hydraulic fluids are the most studied category taking into account this point of view. These fluids and other ones as lubricants are also presented in the extractive mining industries where accidents caused by a spontaneous fire have extremely serious consequences both for infrastructure and utilities and for the safety and health of the workers.


The transposing process of the Council Directive 92/104/CEE into the national legislations of the Euro-
ean countries was long, the Directive from 1992 having the most numerous transposing process in 1998-2001.

In the Romanian legislation, this Council Directive was transposed very late, only after 14 years from the coming into force of the Council Directive, due to a Government Decision no. 1049 dated 09.08.06 [12] concerning the minimum requirements for assuring the security and health of the workers from surface and underground extracting industry.

Based on this regulation, the Government established the minimum requirements necessary for assuring the security and health of the workers involved in the surface and underground mineral extraction industry. The normative document was coming into force from October 1, 2006.

1.2. The Requirements Enforced by the Directive for the Hydraulic fluids

These requirements are given in Part C of the Annex of the Directive (PART C. Special minimum requirements applicable to underground mineral-extracting industries) and are related to article 11, Fires, combustions and hearings, as following:

11. Fires, combustions and hearings

11.1. Provision must be made for the prevention and, where appropriate, the early detection of spontaneous combustion.

11.2. Flammable materials taken into underground workings must be limited to the quantities which are strictly necessary.

11.3. Where it is necessary to use hydraulic fluids (fluids for the transmission of hydrostatic and/or hydrokinetic mechanical energy), fluids which are difficult to ignite must, as far as possible, be used in order to avoid the risk of fire and its spread.

The hydraulic fluids must satisfy specifications and test conditions relating to fire resistance and hygiene criteria.

Where hydraulic fluids are used which do not satisfy the specifications, conditions and criteria referred to in the second subparagraph, additional precautions must be taken to avoid the increased risk of fire and its spread.

The Romanian text of the Government Decision has a high degree of fidelity as compared to the Directive text, including the content of the article 11 from Annex 3 (The minimum requirements especially applicable to extractive underground mining).

2. EUROPEAN STANDARDS FOR IMPLEMENTING THE DIRECTIVE

The European Committee for Standardization (CEN) has the mandate from European Union to develop standards in order to sustain the implementation of this Directive. Among these new supporting standards are the three ones concerning the technical fluids:

- EN ISO 20844:2004 Petroleum and related products - Determination of the shear stability of polymer-containing oils using a diesel injector nozzle (ISO 20844:2004);
- EN ISO 20823:2003 Petroleum and related products - Determination of the flammability characteristics of fluids in contact with hot surfaces - Manifold ignition test (ISO 20823:2003);

The texts of all these three EN ISO standards have been approved by CEN, from the ISO standards without any modifications.

These three standards benefit from transposing in short time in Romania, as recognition of the importance and gravity of the problems related to these fluids and also as results of the requirements imposed by the accession process of Romania to EU. These three standards have come into force as Romanian standards in 2004 (SR EN ISO 20844:2004, SR EN 20823:2003, SR EN ISO 20623:2003 [16-18]), two years before the Romanian transposing of the Council Directive, witch took place only in 2006.

The three testing methods are regulated by identical Romanian standards in content as compared to the corresponding European standards that were imposed by the Council Directive 92/104/EEC. National adoption methods for all these three Romanian standards was the endorsement method [1].


The four ball machine is often used for testing of the extreme pressure and anti-wear characteristics of lubricants, because of its constructive simplicity and easy utilization, although obsolete and given little correlation to the behaviour of the lubricants in real applications from the point of view of some researchers. Some standards presents the conditions and procedure of the test and equipment. There are some modified four ball machine that do not conform to standards, also.

At this time, this determination is done in a few Romanian accredited testing laboratories, in agreement to the requirements of the Romanian standard STAS 8618 [19] or to the American or German standards (ASTM D2596 for greases, ASTM D2783 for lubricant fluids, IP 239 and DIN 51350/1-5 for lubricants).

The standard SR EN ISO 20623:2004 [16] is the national adoption by the endorsement method of the standard EN ISO 20623:2003 Petroleum and related products - Determination of the extreme-pressure and anti-wear properties of fluids - Four ball method (European conditions) (ISO 20623:2003). This standard presents the determination and measurement
method for the extreme-pressure and anti-wear properties of the fluids by the help of a four ball machine. The testing conditions are those applied in European standard and allow a classification of the lubricant properties of fluids, the test results being introduced in the product specifications. The standard describes the four ball machine for testing the lubricant as specified (fig. 1).

Fig. 1. Mechanical design of the testing area in four ball machine: 1. ball chuck holder; 2. ball chuck; 3. cam for removing ball chuck; 4. ball pot assembly; 5. ball pot mounting disc; 6. trust bearing; 7. cross head; 8. brass shims; 9. rubber disc; 10 step bearing; 11 counter-weighted lever arm; 12 fulcrum; 13 step bearing; 14 pressure pin [16].

2.2. Determination of the Shear Stability of the polymer-containing oils using a diesel injector nozzle


This standard describes the method and equipment (fig. 2) for evaluating the shear stresses applied to mineral and synthetic oils and to other fluids containing polymers, using a Diesel engine injector. The shear stability is measured by the changes in viscosity of the tested fluid, caused by the polymer degradation during the fluid testing. Under regular conditions, this international standard is applied to the hydraulic fluids included in the categories HR and HV as defined in ISO 6743-4 and specified in ISO 11158, but it could be also applied to fire-resistant hydraulic fluids from categories HFA, HFB, HFC and HFD, under the modified conditions as specified in ISO 12922.

A formal correlation between viscosity loss (or the absence of this loss) during this tests and that obtained in actual service of the same fluids could not be established. Although, the test offers standard conditions for evaluating the polymer stability under thermal and oxidative stresses. Usually this test is used by the producer of the fluid (oil, additive) as a tool for classification the existing and potential formulae of fluids.

Fig. 2. Shear stability test rig: 1 - diesel nozzle; 2 - vapourisation chamber; 3 - chamber seat; 4 - distribution plate; 5 - cooling vessel; 6 - 3 way stopcock; 7 - fluid reservoir; 8 - main support; 9 - pump pipe; 10 - pump screw; 11 - injection pump; 12 - electric drive; 13 - counter; 14 - aeration screw; 15 - high pressure pipe; 16 - over-flow pipe; 17 - pressure gauge; 18 - temperature gauge [18].

2.3. Determination of the Flammability Characteristics of Fire Fluids in Contact with Hot Surface. Manifold Ignition Test

The standard SR EN ISO 20823:2004 [17] is the national adoption by the endorsement method of the standard EN ISO 20823:2003 Petroleum and related products - Determination of the flammability characteristics of fluids in contact with hot surfaces - Manifold ignition test (ISO 20823:2003). This standard gives a testing method for determining the relative flammability of the fluids when the fluid contacts a hot metallic surface having at fixed temperature. The method also allows establishing the ignition temperature of the studied fluid by increasing the manifold temperature.

This presented testing method and test rig (fig. 3) is mainly used for assessing the resistance to ignition of the fire-resistant fluids that are, by definition, difficult to be ignited. The procedure given in this international standard is also specified in ISO 12922-1999, Lubricants, industrial oils and related
products (class L) – Family H (hydraulic systems) – Specifications for categories HFAE, HFAS, HFB, HFC, HDFR and HDFU.

Fig. 3. Simulated manifold test rig:
1- sheet metal box, 2- thermocouple; 3- tube of corrosion-resistant steel; 4- rod of corrosion-resistant steel [17].

Many specifications related to hydraulic fluids and oils include the results of some others tests concerning the fire resistance and flammability, the shear stability and the determination of extreme-pressure and anti-wear properties, taking into account other standards than those involved in this study. The flammability characteristics are included in a list that includes standard and non-standard tests and methods but a complete list is very difficult to do [6, 8, 10]. Any new application could need a new test for certifying how the material (especially a fluid) behaves in the presence of fire. Among these characteristics there are: the flash point (ASTM D92-52), the fire point (ASTM D92-52) etc..

3. THE STAGE OF IMPLEMENTATION OF EUROPEAN STANDARDS IN ROMANIA

The three testing methods now are not performed in our country for technical fluid conformity assessment by taking into account the requirements of the European directives. The project CEEX-M4-452 “Adoption and Implementation of Test Methods for Lubricant Conformity Assessment” includes applicative research concerning these testing methods.

In the Romanian laboratories the test on four-ball machine is done under the requirements of the Romanian old standard [19] or ASTM standards and the test for the shear stability are done in very few laboratories. There is no evidence of doing tests for flammability characterisation. Negative answers from 10 laboratories having RENAR 1 accreditation for analysing, testing and research on fuels, oils, lubricants were received. These laboratories confirm that they can not perform any one of the three tests under the requirements of the European standards, as imposed by the Directive 92/104. These laboratories are: ICERP Ploiești, ICMET Craiova, INCERP - Cercetare Ploiești, LAREX CNIEP - Centrul Național pentru Încercarea și Expertizarea Produselor, Rompetrol Quality Control, Petrotel Lukoil Ploiești, Rumenul, Societatea Națională a Petrolului “PETROM” - Sucursala ARPECHIM.

Some laboratories explain the reasons why they could not do these tests, especially the absence of the necessary equipment and some of them could do one or two of these tests but in accordance to other standards (ASTM or Romanian ones).

4. CONCLUSIONS

One of the strategic aims in the Romanian oil industry is the reconstruction of the productive and exploitation sectors in accordance to the European standards.

In spite of this strategy, our analysis reveals that the laboratories accredited for analysis, tests and researches for fuels, oils, and lubricants have not the possibility to perform laboratory tests as required by a producer interested in testing the following properties of a fluid: extreme-pressure and anti-wear properties of fluids using a four ball machine; shear stability of polymer-containing oils using a diesel injector nozzle and flammability characteristics of fluids in contact with hot surfaces, taking into account the requirements of the Council Directive 92/104/EEC.

Analysing the European level as concerning the above-mentioned tests, the authors noticed that these tests are done by few accredited laboratories and almost based on American standards.

An explanation would be that short period of time considered from adopting these standards and the complexity of the accreditation procedures for new tests. One would not neglect the important investments necessary for endowment with complex equipment as required by these standards.

The list of hydraulic fluids possible to be selected and the tests that these fluids have to pass, will have to be known and set even in the designing stage of the equipment in order to introduce necessary solution for reducing fire risk. It is also important to analyse similar accidents related to the real applications in order to notice possible improvements in equipment, process and environment control and for workers’ training.

The accomplishment of the research project will allow that our Technical Fluid Testing Laboratory – LubriTEST to be among the first ones in Europe that have these three tests for determining several properties of the technical fluids.

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