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3 POSITIONS MODEL

PROBE SVA-130

FUELS STABILITY ANALYZER

S-VALUE – ASTM D 7157

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Why the measurement Fuels Stability test has becomes so important ?

Why has this type of measure become so complex ?

Simple and fast explanation

- **What type of products are covered by which is the notion of fuels stability ?**

  Originally the products were mainly those from refining units, for the control of production units. Now all the fuels, crudes oils of all kinds, marine fuels and other new products, can be tested and analyzed with S-Value unit.

  The lower limit of 0.2% of asphaltenes mass is considered as the lower limit of detection for the type of measurement.

- **Market application**

  Relevant oil cuts: Diesel / Domestic Fuels / Marine Fuels / Heavy Fuels

  Crudes Oil: 636 different types of Crudes Oils inventoried

  Control of Thermal Cracking unit (basic application), Visbreaker Products, Hydrocracking product H-Oil

- **What does the term «Stability of fuels» mean ?**

  Fuels are composed of many constituents, some of which, like asphaltenes, can, depending on the conditions to which they are subjected, to go from a liquid state to a state, called «granular».

  The reasons for the transition from the liquid state to the granular state are very numerous, complex, and sometimes difficult to identify.

- **What happens in case of instability ?**

  This formation of granular deposits is called «flocculation» or «peptization». This formationcan appears depending on environmental conditions and more frequently when mixing two or more fuels together.

  When this flocculation or peptization occurs, this means that the limit threshold stability of the fuel or the mixture of fuels, is reached.

  When the threshold of instability is reached or exceeded, particles in the form of granular deposits, will be generated in more or less important volume, depending on the nature and the mass of asphaltenes present in the fuel.

  The other components, according to their own nature, such as maltenes or sulfur, can either contribute to flocculation or increase the speed of formation. The action or impact of these components is unpredictable.

- **What are the consequences ?**

  The consequences are many. They can affect the pumping of fuels, their transport, their mixture, but the most serious problem occurs when using fuel oils as combustible.

  It often happens that boats remain blocked due to the impossibility of pumping the fuel because of a very high flocculation density due to unexpected flocculation.

  Examples could multiply. It is therefore sufficient to mention, to understand the importance of the problem, the figures of a 2014 report that estimated tens of billions of dollars per year, the cost of uncontrolledand uncontrolled fuel stability.

How was the stability of the fuels and their mixtures determined ?

In previous decades, the measure of stability was determined by calculation. The fuels were mixed in various proportions and the measurement of flocculation was done with the ASTM D 4740 (Spot test). TSP, Total sediments Potential, ISO 10307-02, was also used. The data was entered in calculation software, and operated in a mode specific to each company.

But this involved on the one hand, a number of important tests to value the data's, and a guarantee of stability over time of the fuels concerned. The guarantee of stability over time being by definition impossible to estimate, one can imagine the consequences of such an approach.

Risks and uncertainties by using only the asphaltenes mass

The most telling example is the following

Two fuels A and B are mixed at 50% / 50%. A spot test is done on the mixture to check if flocculation has occurred.

Fuel A : 11.8% mass of asphaltenes: S = 3.2
Fuel B : 10.4% mass of asphaltenes: S = 2.2

Fuel A is mixed 50% / 50% with a fuel D. A spot test is made on the mixture to check if flocculation has occurred.

Fuel A : 11.8% mass of asphaltenes: S = 3.2
Fuel C : 0.4% mass of asphaltenes: S = 1.3

It is found that the nature of fuel C, is so incompatible with that of fuel A, that even with a very low content of 0.4% mass, Fuel A is destabilized.

This demonstrates the need to know the stability value of each fuel. Data's provided by the S-Value device (ASTM D 7157), produced by ROFA France.

Uncertainty of the ASTM D 4740 drop test (Spot test).

This test shows the state of stability, or flocculation of a mixture of fuels, but not defined the basic parameters of stability, and the parameters in relation to.

Moreover the spot test has a limit in % of mass of asphaltenes large enough to be able to make a valid measurement. Finally, it does not identify the impacts of slurry's and other contaminants in fuels.

TSP: Total Sediments Potential, ISO 10370-02

Means all types of particles, sediments, asphaltenes, others will be weighted.

Test method is done at 100°C / 24 hours. Then according all lab experience, these conditions, can modify asphaltenes structure, by consequence can impact also stability of these ones.

S-Value measurement principle

The principle of measurement is simple and very easy to apply. It consists of the preparation of 3 dilutions with different ratios of the two fuels. A stability reserve is made by adding a volume of toluene in each dilution. Then, after a period of a few minutes of stabilization and mixing, a progressive and controlled titration with Heptane is started. The measurement curve of the signal crossing the dilution is recorded. When flocculation will occur, the signal will record its size and shape. This size and form, will inform the operator on the nature of the relationship between the two fuels. The software will detect and calculate the various parameters described in the next chapter.

S-Value measurement analysis parameters (ASTM D 7157)

Stability is expressed by the parameter «S». The value of this one must not be lower than 1.35 / 1.45 according to the types of fuels. The higher the value, the greater the stability.

The stability reserve of asphaltenes, which is the capacity of asphaltenes to remain liquid, is expressed by the parameter «Sa». The higher the value, the more important the reserve. Below 0.4 this can become critical.

The stability reserve of the oils constituting the matrix of the mixture is expressed by the parameter «So». The higher the value, the more important the reserve.

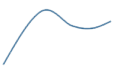
All of these 3 parameters give a complete information on the stability and the capacities to remain stable, which make it possible to take the appropriate decisions.

Different measurement curves depending on the nature of the products

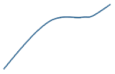
The curves, in addition to the analysis parameters, offer very valuable information on the nature and behaviour of the fuels.

Standars curves

High % mass of asphaltenes

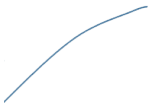


Low % mass of asphaltenes

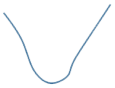


Very low % mass of asphaltenes

Suspects curves



No detection, fuel too stable oralready flocculated



Fast flocculationduring teststart. Fuel very instable

Presence of slurry orother contaminants, having a delay in flocculation process

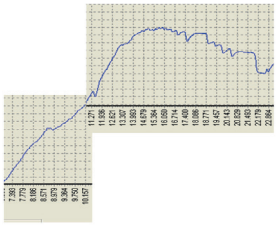
Curves not allowing to initiate a measurement

No detection, fuel too stable or already flocculated

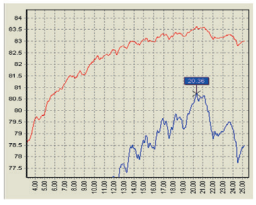
For each of these types of curves, we have a document explaining the reason and giving the procedure to master it.

Nonlinear detection curves Some examples

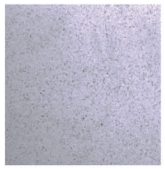
Example curve showing that flocculation of the most important type of asphaltenes is a long process, during 10 ml of Heptane titration. Pic of detection is not really precise and could generate regression precision weakness.



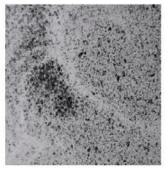
Example curve showing that homogeneity or presence of particles generate a non linear curves, with many pics. Even if we have a detection this could generate regression precision weakness.



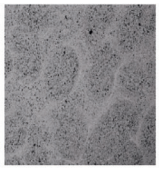
Special check with microscope



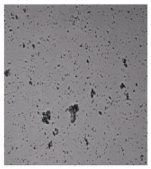
Clear sample with very few particles



Sample with a lot of organic particles, affecting floculation



Clearly asphaltenes organisation is present in different structures



Contamination with large particles is present

Conclusions

It is impossible to predict with certainty the compatibility between two even known fuels. Clearly and through thousands of tests and experience, only a real-time measurement of stability can provide users with the expected support in this area. Any other form of calculation or estimation involves a significant risk, with often very expensive consequences, which can be completely eliminated by theuse of the S-Value device.

ROFA France offers specific training, in our facility, in order to transfer all required know-how.