Close and Return

HYDROGEN ELIMINATION FROM A 225 KV HPOF PIPE-TYPE LINE

Pierre LINOIS, RTE-TENP (France), pierre.linois@rte-france.com
Gilles BONNARDOT, RTE-TENP (France), gilles.bonnardot@rte-france.com
Serge GAZARIAN, RTE-TENP (France), serge.gazarian@rte-france.com

ABSTRACT

In RTE network, numerous oil-static lines show very high amounts of H_2 in oil, which makes operation not reliable. An oil-reprocessing method, using local bleeding at semi-stop joints, was elaborated.
The pipe is kept under nominal pressure for avoiding H_2 bubbles generation in the pipe. While collecting oil, continuous elimination of H_2 is made according specific security requirements.
2 exemples are related. Advantages of the method are discussed.

KEYWORDS

HPOF pipe-type, oil-static, hydrogen, security, oil reprocessing.

INTRODUCTION

Since 2002, systematic DGA (Dissolved Gas Analysis) were processed on RTE oil-static lines. Numerous lines showed hydrogen rates in oil much higher than solubility level at atmospheric pressure. In case of pressure fall in the line, free gas generation within oil can make operating hazardous and be prejudicial to dielectric strength, even when paper dielectric qualities are still very good. For operating these lines further in satisfactory conditions, excess hydrogen has to be eliminated. This article describes a method for bleeding locally the gas loaded oil. RTE choose this method preferably to complete draining and refilling of pipes.
Because of the wide range of explosivity for air-hydrogen mix, the process pays special attention to security. First experiences are described.

OIL-STATIC LINES SURVEYING AT RTE

RTE operates 254 km of 225 kV oil-static HPOF pipe-type lines (53 lines), from 30 to 50 years old.
In this technology, cables are insulated with paper layers, impregnated with viscous oil. The three phases are set in a steel-pipe, filled with semi-fluid oil, and kept under nominal pressure of 15 bars. Partial discharges (PD) easily occur between paper layers, and produce deterioration of the impregnation-compound, giving decomposition gases. These gases pass through papers, and are collected in compression oil.
Nature and amounts of decomposition gases mainly depends on PD energy level. PD energy level seems tightly related with operation temperature, and so, with thermal characteristics of surroundings. Other parameters certainly interact, such as quality fabrication, nature and ageing of impregnation-compound, thermal decomposition of oil and paper. Anyway, energy level is limited, as paper is destroyed over 350℃ (660℉).
At low energy levels, PD creates very preferentially H_2.

In opposition with many pipe-type cables (mainly in the USA), where oil is circulating, and can degas spontaneously at the pressurization station, RTE pipe-type cables were conceived without oil circulation (oil-static). The pipe is a closed volume, which collects all gases produced within insulation, from the beginning of the line.
Since 2002, systematic DGA, using EDOSS method, are processed on samples taken at semi-stop joints of all oil-static lines. Most lines have already been sampled, and about 30 lines have been interpreted. Results are varying, but, globally, H_2 amounts are by 100 to 1000 times higher than all other gas amounts. Very often, H_2 is the only sign of activity on the line.

GLOBAL ANALYSIS OF DGA RESULTS

Global analysis points out that H_2 moves very easily, and is accumulated at highest points of the line. This phenomenon is active even far below solubility level in oil, and must be taken into account for interpreting DGA results. Hydrocarbon gas are much more static.
H_2 is very easily produced, and is also much less soluble than hydrocarbon gas (70 000 ppmv at atmospheric pressure, vs 300 000 for CH_4, and 2 800 000 for C_2H_4 or C_2H_6). Solubility in oil is roughly proportional to pressure.
Usually, even the highest rates observed for H_2 (over saturation level of chromatograph : 500 000 to 700 000 ppmv) stay dissolved at operating pressure. All other decomposition gases rates are 10^2 to 10^5 times lower than solubility at atmospheric pressure.
Nevertheless, when the line is put out of pressure, H_2 bubbles will be generated within oil, come together and accumulate in higher points of the line. Big gas bubbles will form, which will not dissolve back when pressure returns.
This bubble generation was observed several times. In one case, a big bubble (trapped in the middle of a long flat section) led every morning to disruption through “low pressure” protection relay, when minimum electrical losses caused the bubble contraction. This problem could only be solved by bleeding gases.
In another case, a dielectric flashover happened in a place where free hydrogen was found. This was interpreted as ionisation in non-impregnated gas-filled bubbles between paper layers, which could not be compressed properly by external hydrogen pressure.

In any case where paper-ageing investigation could be processed, analysis revealed no significant ageing (Mean Polymerisation Degree (MPD) usually > 900. By exception, 600 was found ounce), even for lines where high amounts of gas was known.