APPLICATION NOTE

DC test of vacuum integrity in MV switchgear

1. Background

Since the 1950's vacuum has been used as insulation media in switchgears. Even though that technology has proven to be very reliable, over time air will leak into the vacuum chamber and degrade the insulation. Also, a good practice is to measure after transport or accidents. The accepted way to test the vacuum integrity has always been through a voltage withstand test. For field tests DC test is preferred due to the weight and size of the instruments.

2. Method

It is recommended to use a voltage withstand test to verify that the vacuum pressure is still within the acceptable limits.

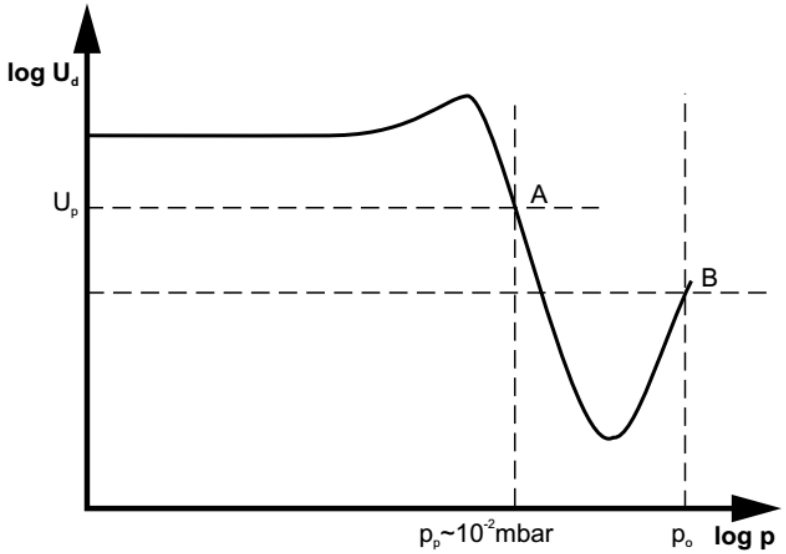

Fig. I. Flashover threshold voltage plotted against pressure in vacuum chamber.

p : chamber pressure
p_o: atmos. pressure
p_p: max. pressure on passing voltage test
u_d : breakdown voltage
u_p : test voltage

Standards recommend using 75-80% of the factory test voltage to provide a margin for normal deterioration, for minor contamination, and for normal voltage surges encountered in service.

Since AC normally is used in the factory, the peak voltage level must be calculated, RMS x √2, see table 1. This DC voltage should be applied minimum 5 seconds up to 1 minute.

VIDAR provide a GO-NOGO light to indicate when an interrupter is judged to have an acceptable vacuum level. The indicator light is switched to NOGO if the leakage current at the test voltage is above some threshold level, for example 300 microamperes.

If the vacuum pressure has degraded to a level where the insulation is not sufficient the resistive current quickly raises above this threshold level. Therefore, this method is reliable to distinguish between an interrupter filled with air and an interrupter with an acceptable vacuum level.

Some instruments have a current measurement instead of or as a complement to GO-NOGO indication. Since the current level on a good vacuum bottle can vary a lot, from a few microamperes to milliamperes, this give no additional value but is rather confusing. The variation depends on many factors like for example humidity, degree of pollution, temperature, normal deterioration, minor contamination or field emissions. Also, there is no point to trend the current since the mentioned causes change from test to test so the current might go up or down without that any specific conclusion can be made.

3. Setup

1. Check that the circuit breaker (test object) is in OPEN position.
2. Check that the master ON/OFF switch on the VIDAR is in OFF position.
3. Connect the protective earth (ground) cable from VIDAR to the station earth (ground).
4. Connect the part with the black crocodile clamp of the high-voltage cable to the control mechanism side of the breaking chamber.
5. Connect the part with the red crocodile clamp of the high-voltage cable to the other terminal on the breaking chamber.
6. Connect VIDAR to the mains power.

4. The procedure:

A safe and secure step by step process should look like this

1. Connect the VIDAR to the test object as described in the setup.
2. Select the desired test voltage depending on the type of breaking chamber being tested (See table 1).
3. Turn the power ON/OFF switch to the ON position. The green lamp beside the switch will light up.
4. Apply the test voltage to the object.
5. Wait until either the green ACCEPTABLE indicator lamp or the red DEFECTIVE indicator lamp lights up and remains lighted throughout at least five seconds.
    a. If the green ACCEPTABLE lamp lights up and remains lighted for at least five seconds the test is complete, and the breaking chamber can be considered in good condition.
    b. If the red DEFECTIVE lamp lights up and remains lighted for at least five seconds.
        i. Repeat the test with reversed polarity.
    c. If the red DEFECTIVE lamp lights up again the test is complete, and the breaking chamber can be considered in bad condition.
    d. If the green ACCEPTABLE lamp lights up this time and remains lighted for at least five seconds the test is complete, and the breaking chamber can be considered in good condition.

Megger

Table 1

Withstand voltage tests for vacuum integrity For medium voltage vacuum interruptors rated 38kV and below			
ANSI C37.06	IEC 62271-1		
Rated voltage	Rated voltage	Rated power frequency withstand voltage	**Suggested VIDAR voltage (Note 3)**
kV,rms	kV,rms	kV,rms	**kV, DC**
	3,6	10	**14**
4,76		19	**20**
	7,2	20	**25**
	12	28	**40**
8,25		36	**40**
15		36	**40**
	17,5	38	**40**
15,5		50	**60**
	24	50	**60**
25,8		60	**60**
27		60	**60**
	36	70	**60**
38		80	**60**
Note 1	Circuit breakers rated at less than 12 kV, may need to be isolated from ground to avoid overstressing the line to ground insulation.		
Note 2	If a circuit breaker is detected bad, the test should always be repeated with reversed polarity.		
Note 3	Always follow the manufacturers recommendation of the test voltage. If this is in AC, multiply with √2 to get the required DC voltage.		
Note 4	For circuit breakers with 36 or 38 kV rating, VIDAR do not reach the required voltage but tests have proven the results to be valid.		