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**Project Title:** Condition assessment of transformer paper using methanol marker

<b>Department:</b>	Chemistry and Process Research Group	<b>Employer:</b>	Bakhtar Regional Electricity Company
<b>Project/Program Manager:</b>	Hoda Molavi	<b>Executor:</b>	Ahmad Ahmadi
<b>Project Financial Code:</b>	216500	<b>Project Quality Code:</b>	CPCBB01
<b>Type of Project/Program:</b>	Idea test	<b>Assistant:</b>	Research assistant

**Project Staff:** Abbas Yousefpour, Sepideh Hamedi, Ali Sabzi, Maryam Kardaani

**Keywords:** Transformer, Insulating paper, Condition assessment, Methanol, Chromatography, Insulating oil

**Project Necessity:** The lifespan of a power transformer is a function of the lifespan of its windings and accessories. For a transformer without fundamental defects, it is very important to evaluate the life of its insulating paper, which determines the life of its windings. The transformer can be considered as a reactor in which the aging reactions of paper and oil depend on parameters such as humidity, oxygen, acids and additives. It is possible to determine the degree of aging of insulating paper and oil through the products resulting from these reactions. Due to the inability of conventional markers such as carbon oxides and furanic compounds, it is necessary to use new markers in order to provide the possibility of assessing the condition of the thermally upgraded insulating papers as well as standard insulating papers.

**Project Goals:** Due to the fact that common markers such as furanic compounds are not able to detect failure in thermally upgraded paper, it is necessary to define a project to evaluate the condition of insulating paper in transformers with thermally upgraded paper or a mixture of ordinary kraft paper and thermally upgraded paper using a new marker. The purpose of this project is to measure the amount of methanol in the insulating oil and also to achieve the relationship between the amount of methanol in the insulating oil and the condition of the insulating paper of the transformer, which determines the life of this expensive equipment.

**Abstract:** At the beginning and after collecting and reviewing articles and scientific documents related to transformer insulating paper and the importance of evaluating its condition, common defects of transformer paper, its destruction mechanisms, different methods of evaluating the condition of transformer paper, the advantages and disadvantages of each method, the new methanol marker and its executive records were studied. Then, after designing the aging tests of transformer paper, preparing the materials, tools and equipment needed to perform aging tests and also to analyze the samples was done. As a result, after collecting the results of experiments and tests, the results and data were analyzed in order to achieve the relationship between the new methanol marker and the condition of the transformer insulating paper. Following, the operational history, maintenance of fifteen selected transformers introduced by the Bakhtar Regional Electricity Company was reviewed. Then, oil samples of selected transformers were performed and various analyzes were done on the oil samples, and the results were collected and classified.

Finally, the results of various analyzes were used to evaluate the condition of the insulating paper of selected transformers based on different methods (amount of oil-soluble gases, carbon oxide method, furan method and also based on methanol marker).

**Steps and Methodologies:** In the first stage, the methanol marker method was introduced and the studies performed on it were reviewed. In the next step, after preparing the required materials and supplies, in order to obtain the required data, accelerated aging tests were performed in the laboratory with the aim of achieving the relationship between methanol and the degree of polymerization of the paper. In the third stage, the operational history, repair and maintenance of power transformers in Bakhtar Regional Electricity was reviewed and fifteen of them were selected and introduced as a priority to check the condition of insulating paper by Bakhtar Regional Electricity Company. In the fourth stage, the sampling (according to IEC 60567 or ASTM D3613) of selected transformer oils was performed by the representative of Niroo Research Institute and the necessary analyzes were performed on the samples. In the last step, the results of the mentioned analyzes were analyzed and the condition of the insulating paper of the selected transformers was evaluated and the priority of their replacement was determined.

**Main Results (technical outputs, patents, papers, books, reports, etc.):**

- Report of the first stage entitled "Introduction of methanol marker method to evaluate the condition of transformer's insulating paper"
- Report of the second stage entitled "Performing accelerated aging tests on oil and paper samples in the laboratory"
- Report of the third stage entitled "Study of operational history, repair and maintenance of the selected transformers by Bakhtar Regional Electricity Company and prioritization of the transformers to check the condition of insulating paper"
- Report of the fourth stage entitled "Sampling of selected transformer oils and performing various analyzes on oil samples to check the insulating paper status of the selected transformers"
- Report of the fifth stage entitled "Analysis of the results of various analyzes and evaluation of the insulating paper status of the selected transformers and determination of replacement priority"