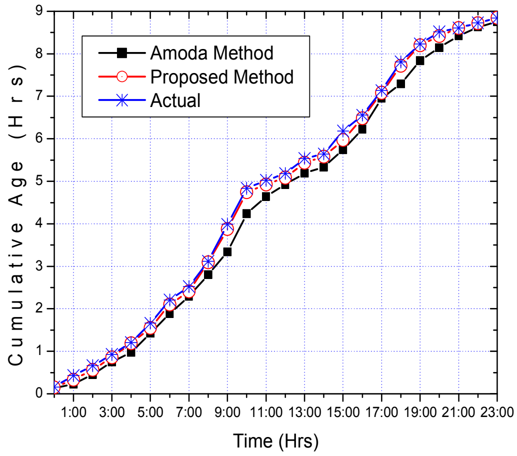

Fig. 9 Cumulative insulation age Comparison for normal load profile

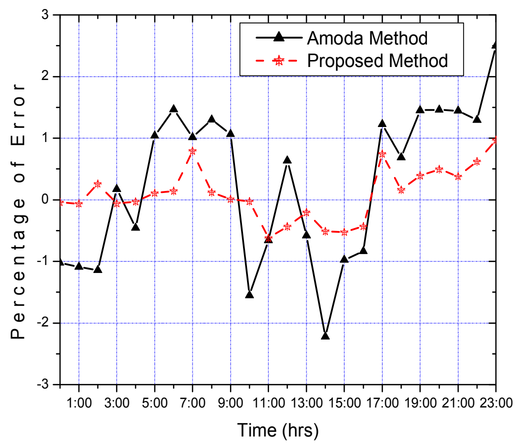

Fig. 10. Hot Spot Temperature: Error Comparison for emergency load profile

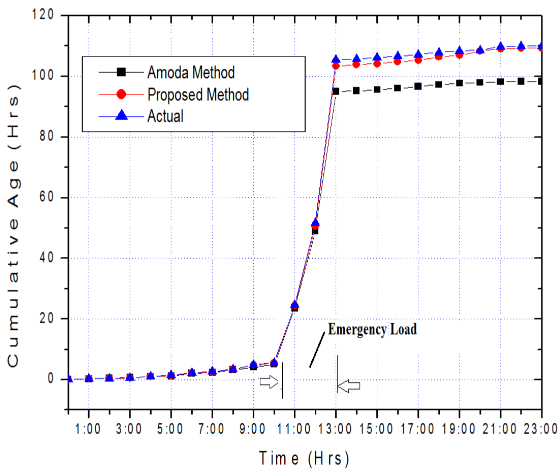

Fig. 11. Cumulative insulation age for emergency load profile

6.3 Environmental variable effects

Fig. 8 and 9 shows that HST and cumulative age calculations are made for semi physical model with normal load profile. Fig. 10 and 11 shows that HST and cumulative age calculations are made for two models with emergency load profile. The loss of life (using Equation (17)) in percentage and in hours is shown in Table 3 for 24 hours load cycle.

In normal load profile model 2 shows better result which is closer to the actual HST and cumulative age. But a the models compared with actual HST and cumulative age, resulting as model 2 is closer to actual and model 1 is away from actual as shown in Fig.8 and Fig.9. The comparison in emergency load the difference is larger than in normal load as shown in Fig. 10 and Fig.11.

Table 3 Percentage Loss of life

24 hrs. Load Cycle	% Loss of Life Model 1	Model 2	Actual
Normal Load	0.004914	0.00493	0.00495
Emergency Load	0.05464	0.05784	0.06058

In order to show the performance of the model as well as its precision and accuracy in HST modelling, 24 hours data's are used to predict TOT in all ranges. Fig.9 shows that addition of wind velocity and solar radiation of model 2. It is able to produce better result. The error between measured and predicted values is minimum.

6.4 Description of MATLAB/Simulink Model

The top oil temperature and hot spot temperature model has been calculated based on IEEE clause 7 and semi physical model equations (1) and (11).

Load and ambient temperature data's are saved in workspace and it is fed to an input of TOT model and the output of top oil temperature rise as a input of hot spot temperature model. Fig. 12. shows the Simulink model of proposed systems which allows additional input of solar radiation and wind velocity to the existing model inputs of load and ambient temperature. The wind velocity component divided in to two orthogonal components and it is fed it separately. Fig.13. shows the subsystem of proposed system which is top oil temperature rise model. Fig. 14. shows the subsytem1 of proposed system which is hot spot temperature model comprising the function of equation (12) and its output is hot spot temperature. Fig. 4 and 5 shows that MATLAB/Simulink simulation output of TOT and HST of waveform for semi physical model with normal load profile. Simulation of TOT and HST are closer to measured value.

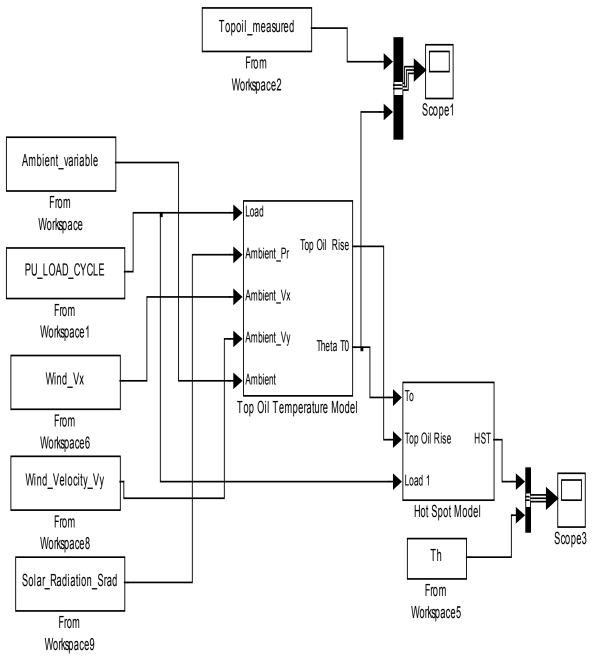

Fig.12. MATLAB/Simulink Model of proposed system

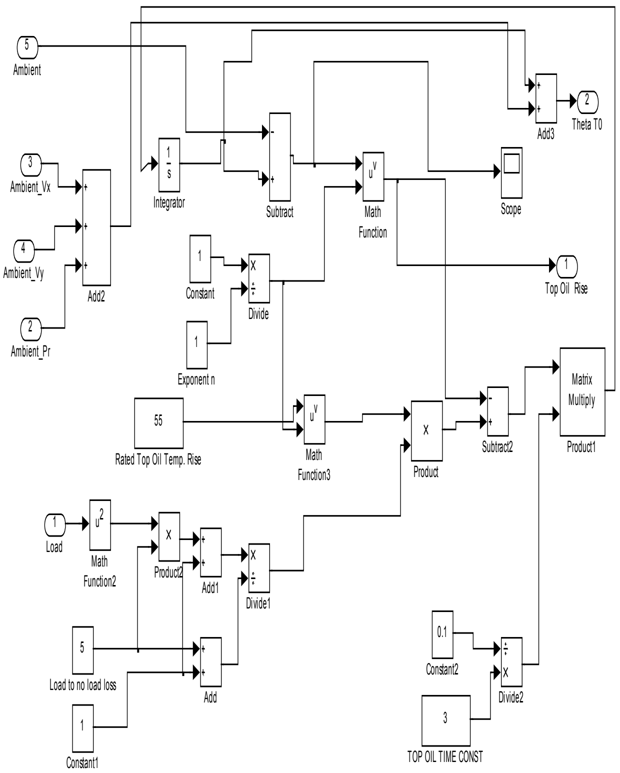

Fig. 13. Top Oil Temperature rise simulink model

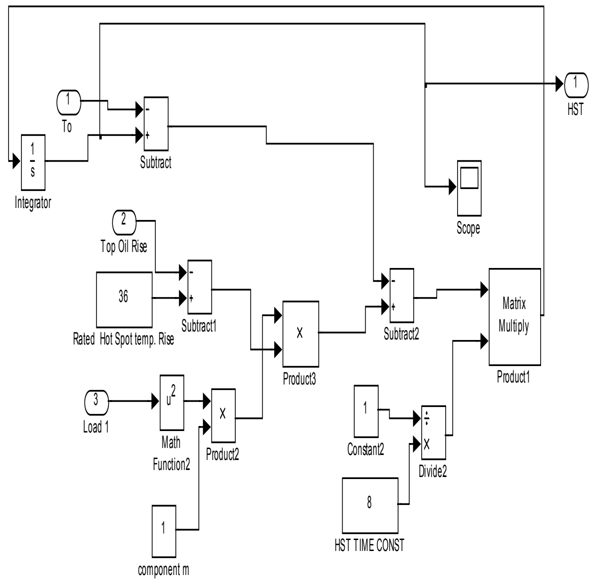

Fig.14. Hot Spot Temperature model

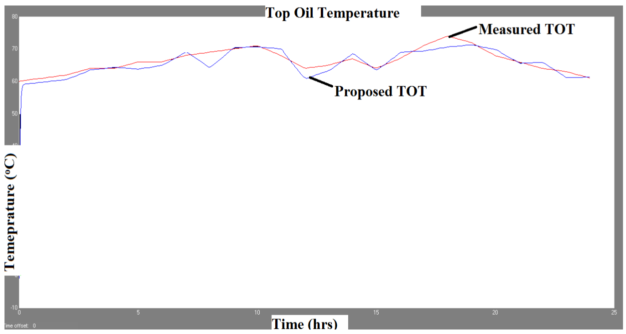

Fig. 15. Top Oil Temperature waveform

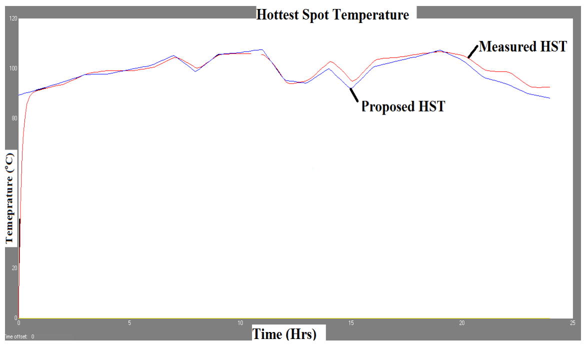

Fig. 16. Hot Spot Temperature waveform

7. Conclusion

In this paper an improved model for the estimation of TOT in transformers was proposed. The authors have used two models to attempt to accurately predict transformer temperature and loss of life for both normal and emergency loads. The actual 24 hours data's of ambient temperature, solar heat flux, and wind velocity in summer season are the base parameters for proposed method. The semi-physically based model leading to the conclusion that any of several models are satisfactory for predicting transformer Hot-Spot-Temperature (HST). The preferred model for predicting HST is the linear semi-physically based model because it permits the use of simple and robust linear regression techniques. In this method, we expected the addition of solar radiation and wind velocity to significantly reduce the gap between actual and predicted. In this paper was shown that model 2 is a good model. Using the proposed semi physical model, the effect of ambient temperature and environmental variables on transformer insulation aging was investigated. Although in this study the proposed model was used to study the effect of environmental variables on insulation life, it is an exact model and used to predict the percentage loss of life the transformer.

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