Heat released from buried pipelines transporting warm hydrocarbons progressively thaws surrounding permafrost forming a thaw halo around the pipeline. Due to the non-uniform distribution of soil properties and massive ice deposits in the permafrost, differential settling of soil under the pipeline is likely to occur. This differential settlement results in bending strain in the pipe's wall which could lead to overstress and possible damage to the pipeline.

This work is dedicated to the prediction of permafrost thaw halo formation around a pipeline. A reasonably accurate predictive model of pipeline thermal interaction with permafrost is difficult but realizable if detailed data on all of the relevant factors influencing this interaction are available. But today obtaining full and precise information about these factors is quite difficult.

The aim of this work is to develop a predictive model that provides high ratio of the accuracy in estimating thawing halo dimensions to the quality of input data. In order to achieve this aim we solved the following problems:

First, we constructed a list of factors (see Table 1) that possibly influence permafrost-pipeline thermal interaction and from this list we developed a model that predicts interaction with a pipeline and thaw halo extent.

Second, we measured the permafrost thaw halo around the oil pipeline (\( \phi = 1.22 \) m) located in Eastern Siberia, Russia (see Figure 1). Measurements of thaw halo extent were taken for two sections of the pipeline after 3 years from the start of its operation. In addition, we collected all information as accurately as possible about local conditions that affect permafrost-pipeline thermal interaction.

Third, we predicted the thawing halo formation around the pipeline using our model and conditions recorded at the pipeline. We compared calculated halo dimensions with measurements of the thawing halo for each of two sections during June and October in the third year of the pipeline's utilization. Figure 2 demonstrates the agreement between calculated and measured results.

Finally, we conducted a series of numerical studies to evaluate the individual influence of each factor on permafrost thaw halo formation (see Table 2), allowing us to estimate the requirements for input condition.

In conclusion, we have developed and tested a predictive model of permafrost thaw halo formation that makes reasonable demands on initial data accuracy and provides sufficient accuracy of calculated thawing halo dimensions. According to the results of the numerical studies, the dimensions of the thawing halo are most sensitive to the temperature of the transported hydrocarbons, thermal conductivity of frozen soil and the initial temperature field of permafrost within the region of the pipeline's thermal influence. This model can be used as a basis for further investigations of the stress state of a pipeline in the conditions of soil subsidence.

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