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## Field observations of cooling performance of thermosyphons on permafrost under the China-Russia Crude Oil Pipeline

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**Abstract:** The buried China-Russia Crude Oil Pipeline (CRCOP) traverses 441-km discontinuous permafrost zone and operated at positive oil temperature since 2011. The underlying permafrost is degrading and thaw settlement is happening in the trench. An instrumented site was established to monitor ground temperature and water content under the CRCOP to evaluate permafrost degradation and cooling performance of thermosyphons installed near the pipe. Field observations show that: (1) mean annual oil temperatures are higher than 0 °C and show a gradual warming trend (average increase by 2 °C during the observation period from 2012 to 2016; (2) the active layer thickness (ALT) increases by 2.7 m and the deep (15–20m) permafrost temperature, 2 m away from the uninsulated pipe, rises 0.2 °C from 2014 to 2017; (3) thermosyphon can cool the soils surrounding the pipe and effectively mitigate thawing of underlying permafrost depending on its number, spacing and working duration; and (4) a thaw bulb surrounding the pipe exists even in winter due to a higher oil temperature. Field observations provide a better understanding of permafrost degradation, cooling effect and design parameters of thermosyphons, and basic data for numerical validation, implications for other similar cold regions pipeline engineering.

**Keywords:** Permafrost degradation; China-Russia Crude Oil Pipeline; Thermosyphon; Cooling performance;

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