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State-of-the-Art of the Problem of Hummock Impact on Seabed and Underwater Pipelines

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ABSTRACT

The analysis of the offshore environment of the freezing seas showed that in these areas the underwater pipelines and the others buried structures could be damaged with high probability by the drifting ice formations of various origins which directly contacted the bottom in the offshore zone.

In this paper the authors analyzed comprehensively the global problems of ice impacts on the sea-bottom and underwater pipelines. The results of this review provide guidance on approaches to estimate the normative burial depth of underwater pipelines in Arctic seas.

KEY WORDS: ice features, offshore zone, underwater pipeline, seabed, ice gouge, burial depth, models.

INTRODUCTION

As a rule, the pipeline transport is the most economic type of oil and gas transport when developing the sea oil and gas fields within the offshore zone of the World Ocean.

In the freezing offshore water areas the hydraulic engineering structures and means of underwater communications in the littoral zone would be in main danger of ice piles formation on the shore and the seabed exaration by the ice formations, such as hummocks, ridges rows, grounded hummocks, icebergs, etc. As a result of this process, the keels (i.e. the underwater parts) of the ice features leave long trenches in the seabed named gouges. Direct contact of a keel to a pipe within the gouge caused damage of the pipeline in most cases because of possible both dynamic and static loadings from ice. In these conditions the pipeline burial into the ground was the basic and the most applied way of the pipeline protection from external ice impacts.

Thus, the basic problem in designing a route of the underwater pipeline under ice conditions was the substantiated assignment of its burial depth into the ground of the seabed. The comprehensive engineering analysis of methods of the underwater pipelines burial depth calculation should include the following factors as a minimum:

- Characteristics of hydrometeorological/ice conditions of the deposit water area, such as:
  - Velocity and direction of ice drift;
  - ice age;
  - Physicomechanical/strength parameters of hummocks and grounded hummocks;
  - Geometrical parameters of ice features;
  - Gouge parameters in the process of the seabed exaration by the ice features;
- Characteristics of the ground footing under the route of the pipeline:
  - Types of ground and conditions their occurrence;
  - Physicomechanical/strength properties of the footing ground and backfill for trenches;
- Characteristics of the underwater pipeline route:
  - Scheduled - high-altitude position of the pipeline route;
  - designed water depth in section line;
  - Diameter of pipe and thickness of walls;
  - Operational conditions of the pipeline.

Overall the last decades the sufficient statistical material on properties of the footing ground in the promising areas of the oil&gas field construction was accumulated. Besides, the existing research methods of the ground parameters were well approved during several decades on an extensive material of construction of various engineering structures. Also it is necessary to note that the basic properties of constructional materials (steel, etc.) were investigated theoretically and experimentally on the sufficiently high level. Thus, when designing pipeline systems in conditions of the freezing seas, obtaining of authentic estimations of hydrometeorological/ice regime parameters of the water areas was the most difficult and insufficiently investigated aspect.

The problem of studying of the ice regime parameters and ice loads on various offshore structures (including underwater communications) arose not long ago in the global practice, and researches in this area were carried out for thirty years at least. Many aspects concerning ice impacts on the sea underwater systems have got no sufficient answers yet and this problem is still at the stage of initial research though certain success has already been achieved in this area.