Floating Production Unit Resistance to Iceberg Impact

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ABSTRACT

It is well known, that floating moored platforms resistance to action of an iceberg is problematic. Usually, an impact of an iceberg or a floating “stamukcha” (i.e. iceberg of salt ice) upon a floating facility is assumed to be irresistible due to a lack of a capacity of the mooring system. In such a case accident preventive measures should be undertaken. These measures imply disconnection of the mooring/riser systems from the turret and the relegation of the iceberg by tow vessels or by the FPU own propulsive devices (thrusters). The disconnection procedures are complicated and dangerous and may be too late. Also a failure or malfunction of the disconnection system may arise. In this case an iceberg impact is inevitable and should be examined. As a first approximation it may be proposed that an impact of an iceberg with a limited weight may be compensated by absorption of its kinetic energy by the FPU mooring system with thrusters assistance. Also, the energy absorption by the FPU rotation (yaw) due to eccentric contact impact should be taken into account. The proposed paper demonstrates that the performance mentioned above can be successfully achieved in the turret moored FPU, owing to the performance of the station-keeping system and the turret rotation capacity supported by the FPU thrusters action (also flexible risers system safety taking into account). Here the problem is not only to absorb the energy but also to protect the mooring lines and risers against a direct action of underwater ice features of the iceberg.

KEY WORDS: FPU (Floating Production Unit), ice force, iceberg, ice ridges (floating grounded hummock-“stamukcha”), iceberg drifting speed, iceberg energy, mooring system (MS) parameters, computer simulation.

INTRODUCTION

Design of platforms for oil and gas production on the Russian offshore leads to the need to overcome extremely severe combinations of environmental conditions. Now the Floating Production Unit (FPU) moored using a rotatable turret seems to be the most acceptable for the Barents Sea 340 m deep water at the Shittokman field. All environmental loads are to be sustained by the FPU station-keeping mooring system (MS), also flexible riser system influence should be taken into account.

Loads governing for the northern Barents Sea are wave loads and drifting ice along with iceberg impact. It is usually assumed that action of an iceberg on a floating moored platform is irresistible. In case of iceberg threat the iceberg physical management- preventing iceberg from permeating into the near-field area or contacting with the facility (G. Crocker et al, 1998) is carried out. If there is no such possibility or in case of unsuccessful outcome of the operation for iceberg withdrawal, the urgent measures shall be taken in order to reduce risks.

The first measure is the disconnection the MRDB (mooring/risers disconnectable buoy) from the lower part of the turret. Even in case of successful disconnection operation the reconnection is intensive and dangerous operation and may take some months. At the same time, it may be presumed that contact of a FPU type facility with an iceberg of limited size and weight may be conditionally safe for the facility and would require some possible emergency actions. Thus, the actual task is to determine limits for dimensions, weight and drifting speed of the iceberg, at which the above stated the emergency prevention actions are not only salutary. Moreover, the mooring system may be designed such to increase its ability to resist iceberg impact.

Sufficient resistance of the proposed MS against ice/iceberg is ensured by configuration and geometrical arrangement of mooring lines taking into account the limited sea depth.

The proposed MS design is aimed at the following:

— To compensate for the static component of forces caused by impact of ice floe including hummocks directly contacting the FPU ice belt;

— To absorb kinetic energy of drifting iceberg by means of increase of potential energy in mooring line tensioning and the FPU rotating;

— To reduce the local dynamic load from an ice floe or iceberg by gradual growth of contact force due to flexibility and damping properties of the mooring system.

Satisfactory operation of the MS designed for the mentioned purposes is maintained by the appropriate turret position along the FPU hull and the thrusters assistance that shall ensure the a salutary FPU heading.

Ability of the proposed turret moored FPU to compensate for the global ice load under ice/iceberg impact may be evaluated by means of an analysis of energy-absorbing properties of the mooring system together with the hull and my be checked by computer simulation of dynamic iceberg-FPU interaction.

Energy absorption is achieved by allowing for a considerable horizontal displacement of the contact point of the FPU from its initial position using a shifting capacity of the flexible risers. In addition, the horizontal displacement of the contact point and hence energy absorption may be increased by use of the rational ship heading control by the FPU thrusters (DNV-OS-E203).

Environmental conditions including iceberg statistics, were assumed for the eastern part of the Barents Sea based on information received from Russian Arctic & Antarctic Institute (AARI) (Zubakin et al, 2006).

The present paper covers development of the mooring system able to resist against floe/icebergs, determination of requirements for the turret...