



Study of Thermal Supply Mode of Floating Nuclear Power Plant in Offshore Oil and Gas Fields



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1. Introduction

■ Application of thermal energy in petroleum and gas exploitation:

- Thermal recovery of viscous oil
- Inhibition of gas hydrates and wax
- Primary processing of products

Floating nuclear power plant (FNPP) – a promising solution to energy and water supply in offshore oil and gas fields



'Akademic Lomonosov' FNPP
Russian Federation



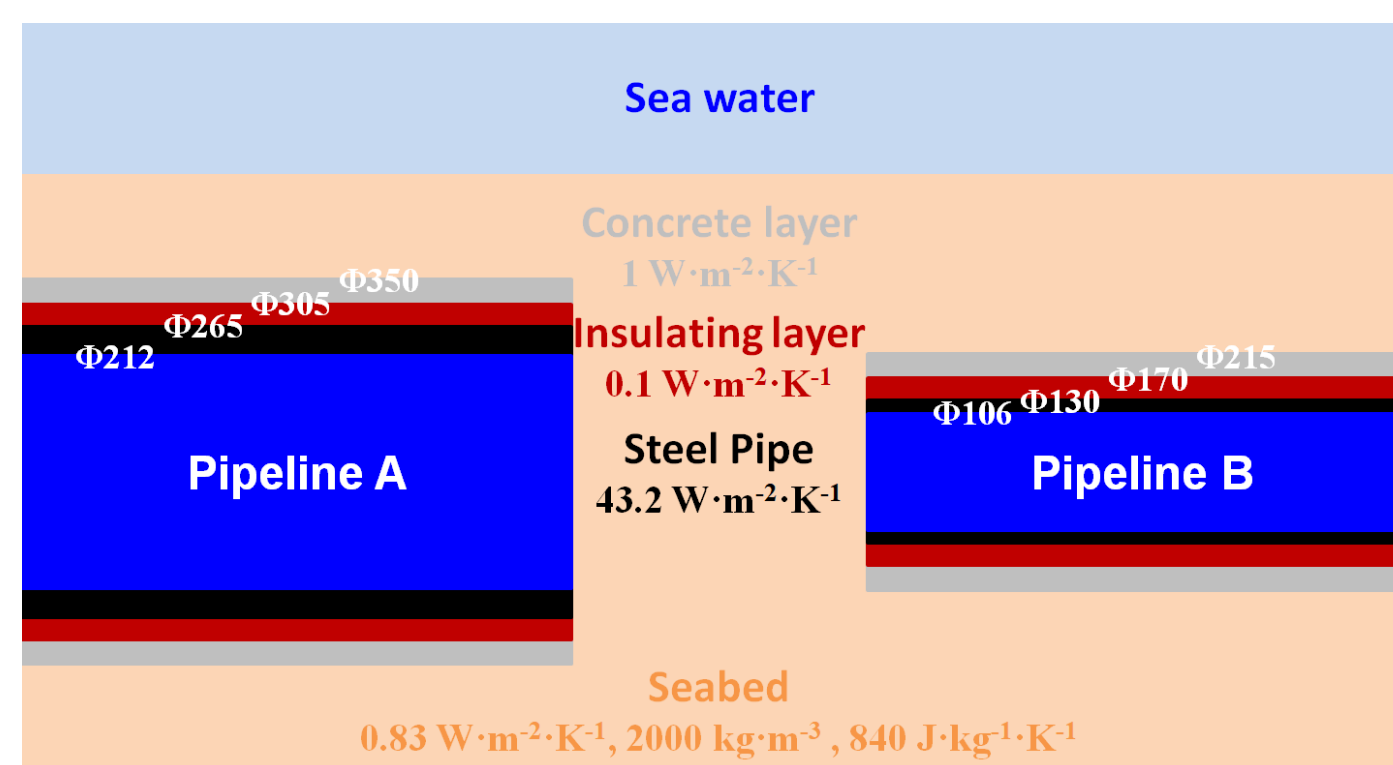
Conceptual design of FNPP
CSSC, China

■ Problems:

- 1) Thermal supply mode
 - Thermal fluids ?
 - Electrical heating ?
 - Hybrid ?
- 2) Platform type mode
 - FPSO-like ?
 - Jack-up ?
 - Semi-submersible ?

2. Calculation

- One-dimensional flow and convective heat transfer in the pipe
- Two-dimensional thermal conductance for the seabed
- Boundary conditions: inlet temperature, pressure and mass flow rate



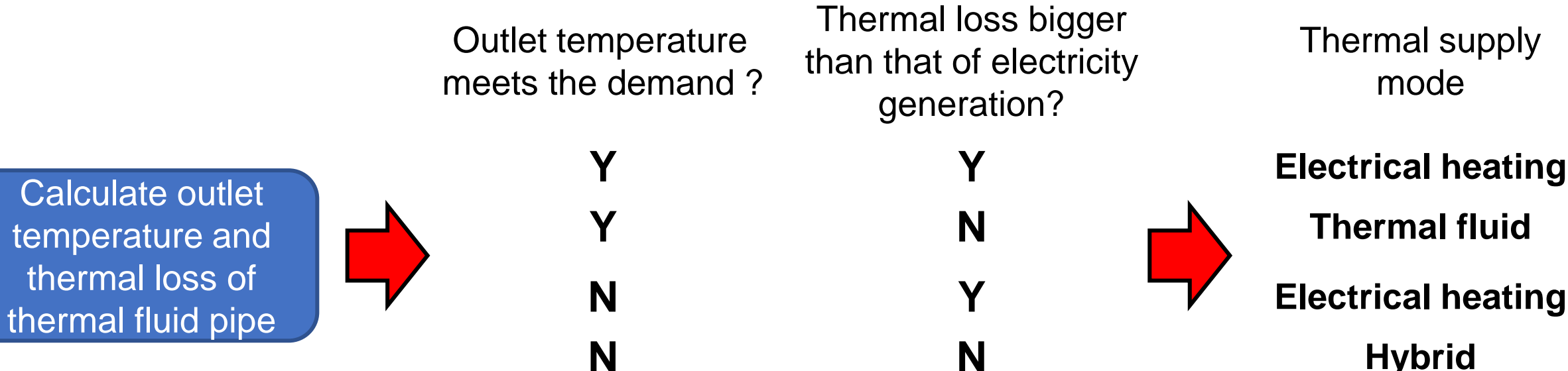
Pipe structure for calculation

3. Power demand

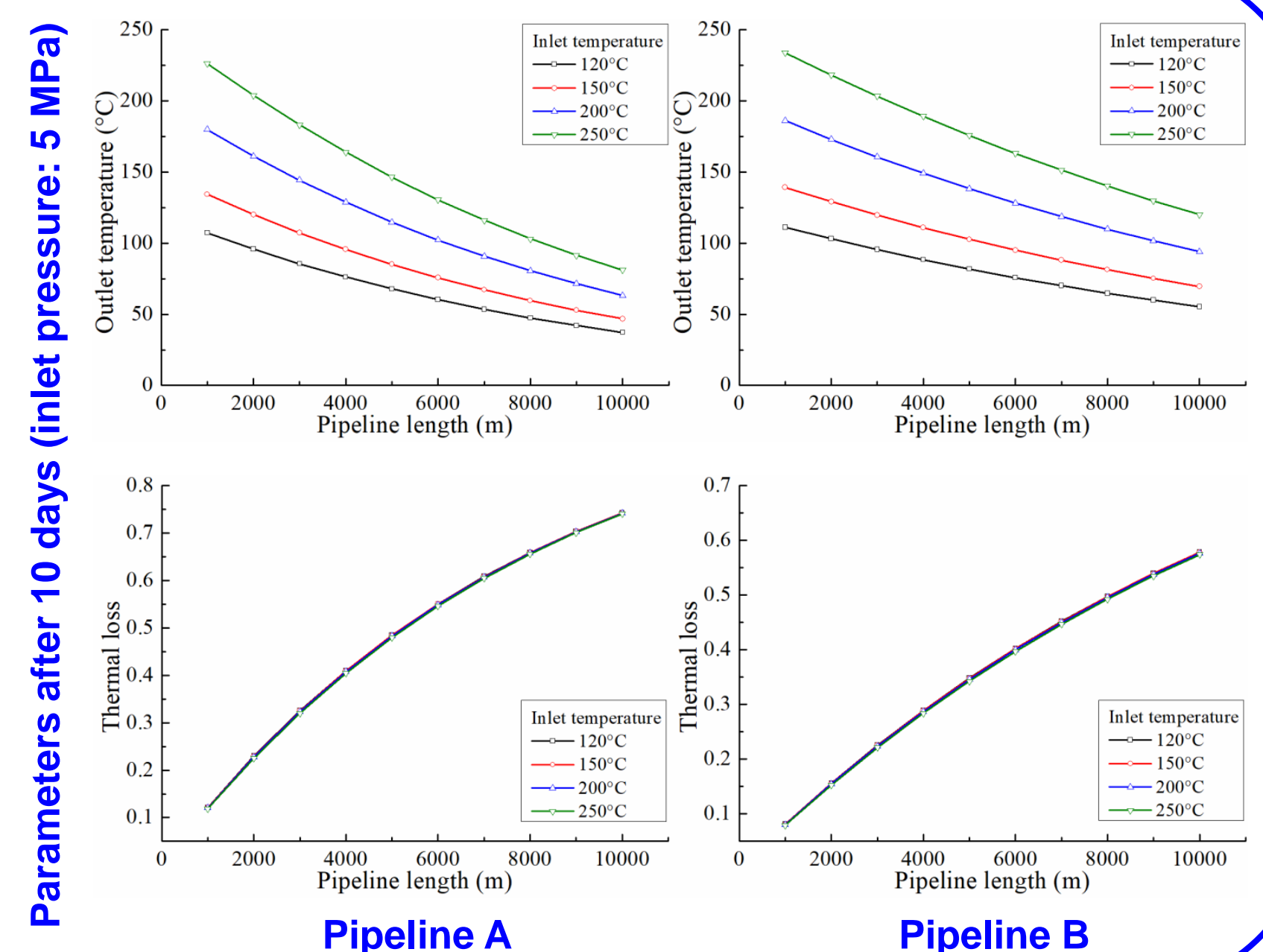
- Thermal recovery: usually < 10 MW for an offshore oil platform
- Inhibition of gas hydrates and wax: 72 km for 25 MW power (fluid temperature: 85 °C)

Thermal power can be supplied by a single marine reactor

4. Thermal supply mode



- Thermal loss is smaller for a pipeline with smaller inner diameter on condition that the thickness of all the pipe layers are the same.
- For the condition of two receiving, the FNPP should be as close to one receiving platform as possible
- 'Economic length': 11.8 km and 17.7 km for the two pipelines, respectively (efficiency of electricity generation: 25%)



5. Platform type

■ Requirements:

- Movable
- Adaptation to sea depth
- Higher supply temperature of thermal fluid (depending on the connection between FNPP and receiving platform)

■ Optimum platform types for Bohai Sea

- Best: Jack-up platform
- Second best: FPSO-like (supply temperature is limited)

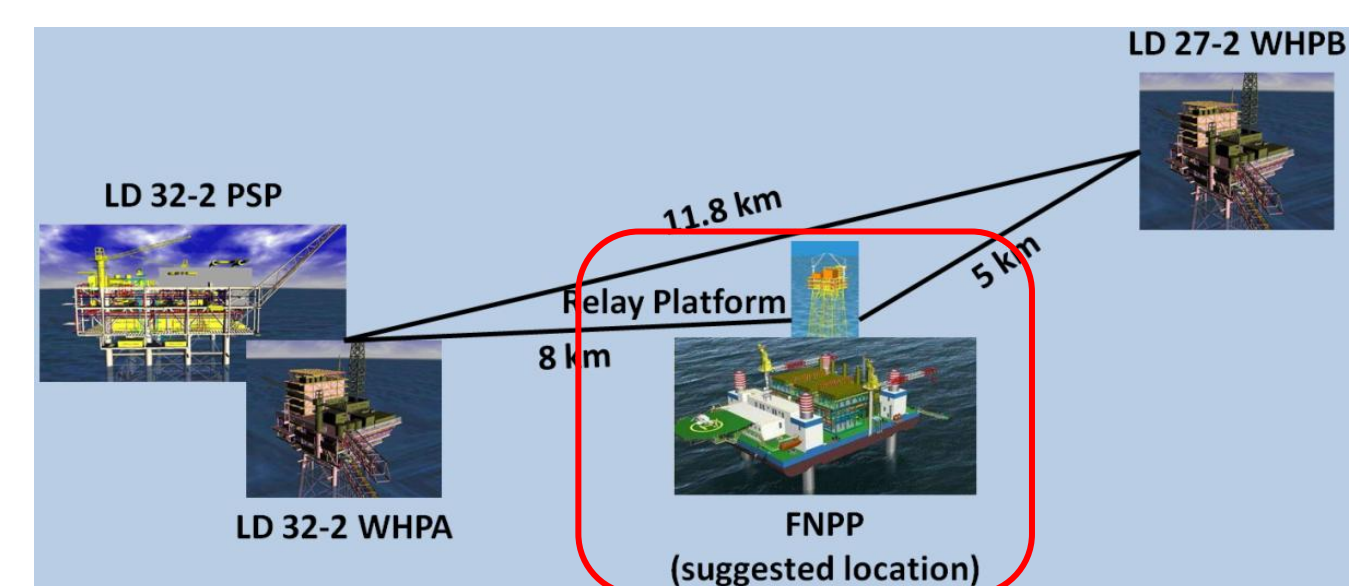
6. Case study: LD 27-2/32-2 offshore oil fields

■ General information

- Average sea depth: 27 m
- Electricity consumption: 24.82 MW
- Thermal recovery wells: 12 (connected to WHPB platform)
- Safety distance between FNPP and oil platform: 5 km

■ General design

- Platform type: jack-up platform
- Reactors: 2 × 100 MW_{th} PWRs, one for electrical supply (25 MW_e) and the other for thermal recovery
- Thermal supply mode: hybrid



LD 27-2/32-2 oil fields

■ Main parameters of reactor for thermal recovery (can be optimized)

- Total electricity power: 20 MW
- Max. electrical heating power: 18 MW
- Secondary loop: 4 MPa/250 °C
- Steam injected: 25 MPa/500 °C
- Injection rate: 20 t/h