# PIOP

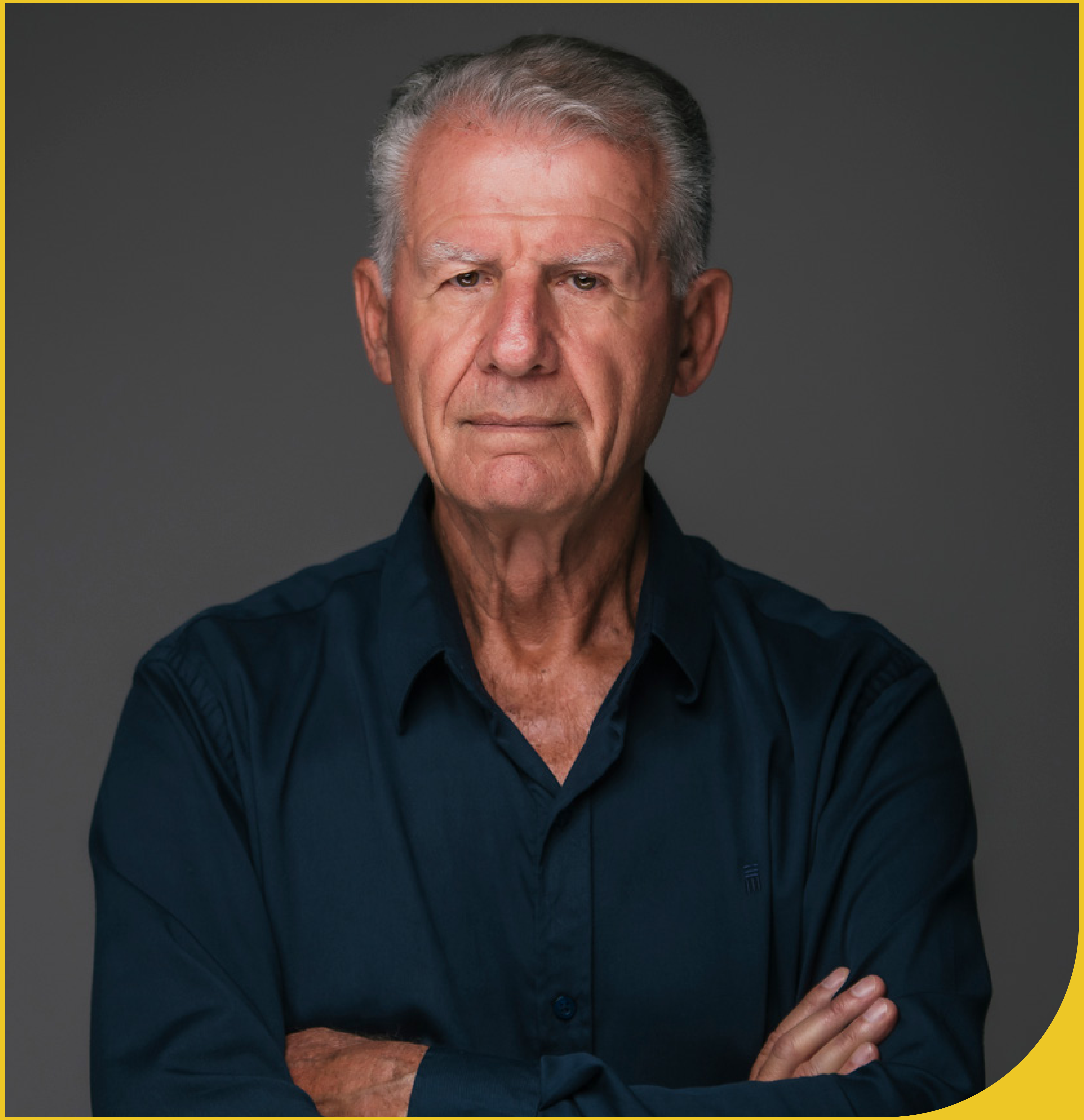
## PIPE INCREASE OIL PRODUCTION

SIÃO PETRÓLEO


SÍÃO
PETROLEO-S.A.

# MARCOS ROGÉRIO PEGORETTI

Mechanical Engineer from the Federal University of Espírito Santo. Founder of Sião Petróleo (1995) with expertise in oil technology.



# LUCIANO VAREJÃO

Mechanical Engineer, graduated from UFES in 1969, Master's in Mechanical Engineering from PUC/RJ in 1973, PhD in Mechanical Engineering from the University of Minnesota, USA in 1979. Postdoctoral researcher at the University of Minnesota between 1990 and 1991. He was a Professor of Mechanical Engineering for 30 years, teaching at PUC/RJ, UFES, and the University of Minnesota.

# THIAGO BASSETTI

PhD candidate in Professional Administration. Consultant for major companies in the mining sector. Specialist in financial structuring and project management.

SIÃO PETRÓLEO

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With 30 years of experience in the oil and gas sector, Sião Petróleo is a benchmark in technological innovation focused on increasing efficiency and sustainability in oil production. The company has a proven track record, with 2 successful patents registered and the execution of over 80 contracts, equipping more than 600 wells in Brazil and the Middle East over the last 20 years.

# THE PROBLEM WITH USING VITs

In oil production, especially in offshore environments, the loss of thermal efficiency in production columns is one of the greatest challenges faced by operators. As oil and the oil/water mixture rise through the well, heat is exchanged with the external environment, particularly in deep waters where temperatures are extremely low.

The problems caused by these challenges, combined with the use of vacuum-insulated tubing, lead to reduced daily production, increased operational costs, and significant financial losses.

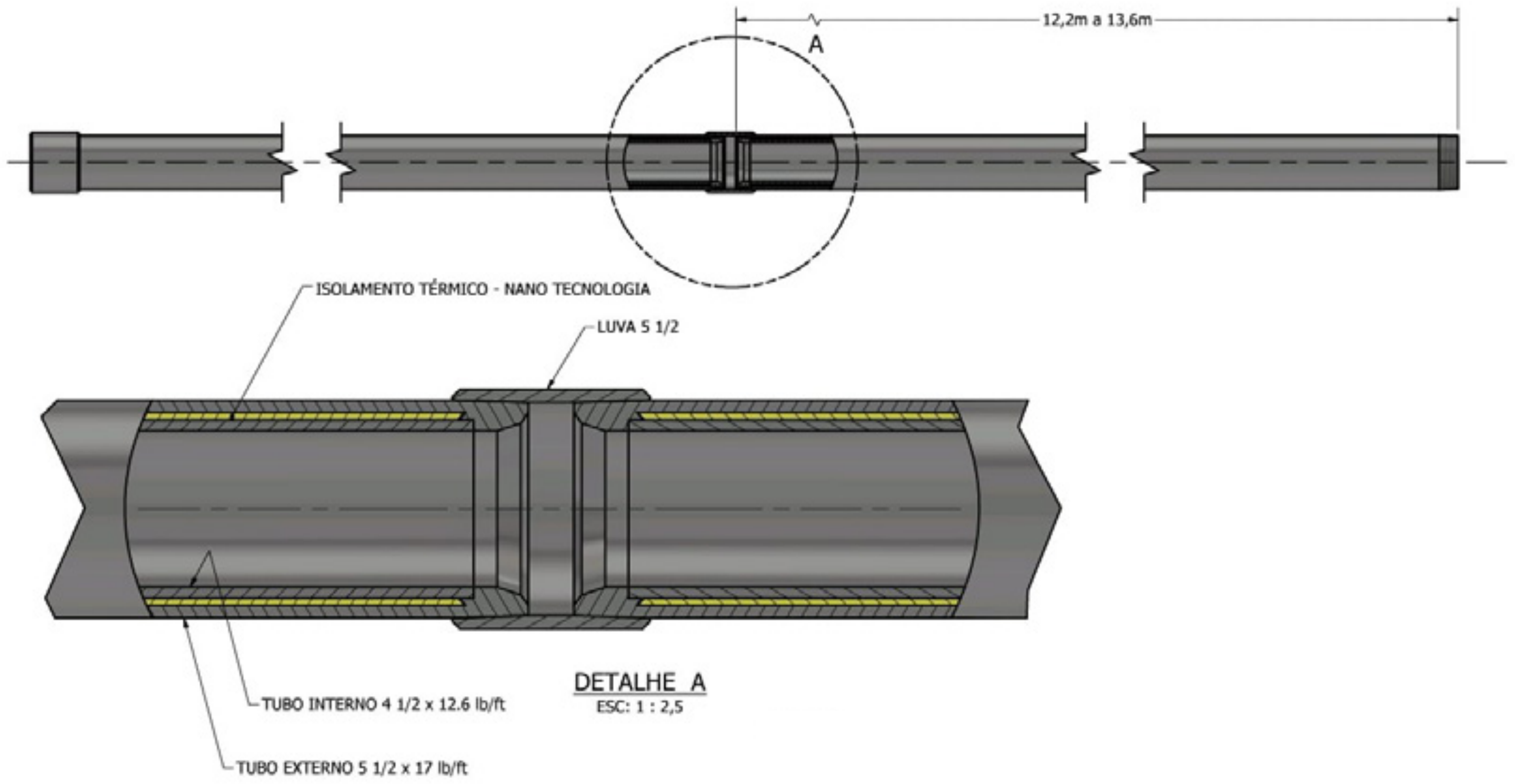
Due to the issues mentioned below, vacuum insulation (VIT) is not used in offshore production columns.

**Susceptibility to the presence of hydrogen, which gradually compromises the thermal insulation of the vacuum.**

**Frequent need for replacement, resulting in operational disruptions and high costs.**

# PIOP TECHNOLOGY

PIOP (Pipe Increase Oil Production) is a groundbreaking innovation developed to address thermal insulation challenges in production columns in the oil and gas industry. It is the first equipment with technology that enables efficient thermal insulation in critical operational areas, such as production columns located below the Christmas tree (ANM) on the ocean floor—something unprecedented and unachieved by other existing technologies.

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# PIOP TECHNOLOGY

PIOP's technology utilizes a special ceramic powder derived from nanotechnology, the same type of solution used by NASA for thermal insulation in space satellites. This material, composed of silica aerogel nanoparticles, is the best-known thermal insulator, thanks to its porous structure filled with nano-vacuums, which reduces heat transfer.

- **Maintenance of constant thermal efficiency for over 20 years without degradation**, unlike vacuum insulation technologies (VIT), which lose effectiveness due to the presence of hydrogen in the evacuated space.
- **Application in vertical and horizontal wells**, adapting to a wide range of configurations and diameters of production columns.
- **Significant reduction in thermal losses of oil to the external environment.** Maintaining greater fluidity, resulting in increased production.

# WHY CHOOSE PIOP

### Production Increase

Simulations show that PIOP can increase production by up to 7% by maintaining the ideal oil temperature for flow, reducing viscosity, and preventing the crystallization of compounds such as paraffins and the formation of hydrates.

### Reduction of Thermal Losses

PIOP technology maintains the oil temperature, increasing fluidity and, consequently, production.

### Lower Pressure Drop

The pressure drop in the well is reduced compared to conventional technologies, allowing production to reach optimal levels without overloading the equipment.

# WHY CHOOSE PIOP

### Lifespan

With thermal insulation remaining constant for over 20 years, PIOP eliminates the need for frequent replacements, reducing maintenance costs and operational interruptions.

### Positive Economic Impact

The return on investment occurs within 3 to 4 years, with accumulated profits over 20 years exceeding 730 million dollars in high-production wells (10,000 barrels/day).

### Sustainability

By reducing heat losses, PIOP decreases energy consumption and, consequently, $CO_2$ emissions, promoting more sustainable operations.

# DATA SIMULATION

1. Vertical Well;
2. Sea water depth - 2,500 meters;
3. Water temperature at the seabed - 3.5ºC;
4. Soil temperature varies linearly from the seabed to the oil reservoir;
5. Oil reservoir temperature - 70ºC;
6. Soil composition - Sand;
7. Completion fluid - Sea water;
8. Production tubing - Range 3;
9. Casing OD 9 5/8 inches, weight of 53.5 lb/ft;
10. The well diameter is equal to the external diameter of the casing + 4 inches;
11. Well depth below the seabed - 1,500 meters;
12. Oil pressure in the reservoir - 4,985 psi;
13. The produced fluid is considered a homogeneous mixture of oil and water.

# PIOP CONFIGURATION

**External tube OD 5 1/2 inches;**
**Weight - 17 lb/ft;**
**Wall thickness - 0.304 inches;**
**Internal tube OD 4 1/2 inches;**
**Weight - 12.6 lb/ft;**
**Wall thickness - 0.271 inches;**
**Tube length - 13.6m, range 3**

Insulating material based on nanotechnology is located in the annular space between the inner and outer concentric tubes.

# PRODUCTION DATA

- **Flow rate: 300 cubic meters per day**
- **Produced water: 150 cubic meters per day**
- **Water percentage: 50%**

Minimum required temperature at the seabed: 63ºC

# SIMULATION DATA

To ensure the reliability of the results, the simulation was conducted using two different numerical methods, Finite Volumes and Finite Elements, addressing two situations:

**1. Production tubing without thermal insulation (Bare tubing).**

**2. Production tubing with PIOP thermal insulation.**

The results obtained by the two numerical methods showed a difference of less than 0.3%, which ensures their reliability.

The main result of the Bare Tubing simulation was the oil pressure at the seabed.

The main result of the PIOP simulation was the oil temperature at the seabed.

# SIMULATION RESULTS WITH BARE TUBING

Mixture flow rate (oil/water): 450.00 $m^3$/day

Water flow rate: 120.00 $m^3$/day

Water percentage: 30.00%

Well depth: 1,500 m

Oil temperature in the reservoir: 85.000ºC

Oil temperature at the seabed: 60.190ºC

Oil pressure in the reservoir: 4,984.853 psi

Oil pressure at the seabed: 2,944.835 psi

Pressure drop: 2,040.017 psi

Pressure drop due to viscosity: 59.434 psi

Pressure drop due to gravity: 1,980.703 psi

Total heat loss through the tubing: 239,904.500 W

# RESULTS OF SIMULATION WITH PIOP

Mixture flow rate (oil/water): 450.00 $m^3$/day

Water flow rate: 120.00 $m^3$/day

Water percentage: 30.00%

Well depth: 1,500 m

Oil temperature in the reservoir: 85.000°C

Oil temperature at the seabed: 77.349°C

Oil pressure in the reservoir: 4,984.853 psi

Oil pressure at the seabed: 2,949.906 psi

Pressure drop: 2,034.947 psi

Pressure drop due to viscosity: 54.382 psi

Pressure drop due to gravity: 1,980.703 psi

Total heat loss through the tubing: 73,858.836 W

Heat loss through couplings: 7,798.057 W

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# ANALYSIS

**Uninsulated pipes (bare tubings) do not meet the minimum required temperature at the seabed.**

**The PIOP tubing not only meets the minimum required temperature at the seabed but exceeds it by more than 7°C.**

Another important observation is that the pressure drop of the PIOP, from the reservoir to the seabed, is less than that of the uninsulated tubing.

If the pressure drop of the uninsulated tubing is OK with respect to oil production, then the oil production of the PIOP can be increased to match the pressure drop of the uninsulated tubing.

Considering the simulated situation, oil production could be increased by almost 10%! This was exactly the purpose of Sião Petróleo's new development. The PIOP was designed with two objectives in mind: to keep the oil temperature high, preventing heat exchange with the environment; and, the most important objective, to increase oil productivity.

# CONCLUSION

**The PIOP technology is durable, extending for more than 20 years.**

**The PIOP technology keeps the oil heated so that its temperature at the ANM exceeds the minimum required.**

**The PIOP increases oil production by up to 7%.**

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