



Development of direct mixing type BOG recondensing system and its energy saving effect

Mitsuru Kozuka, Manager
Toho Gas Co., Ltd.

HOST ASSOCIATION



PROUDLY SUPPORTED BY



HOST PARTNERS

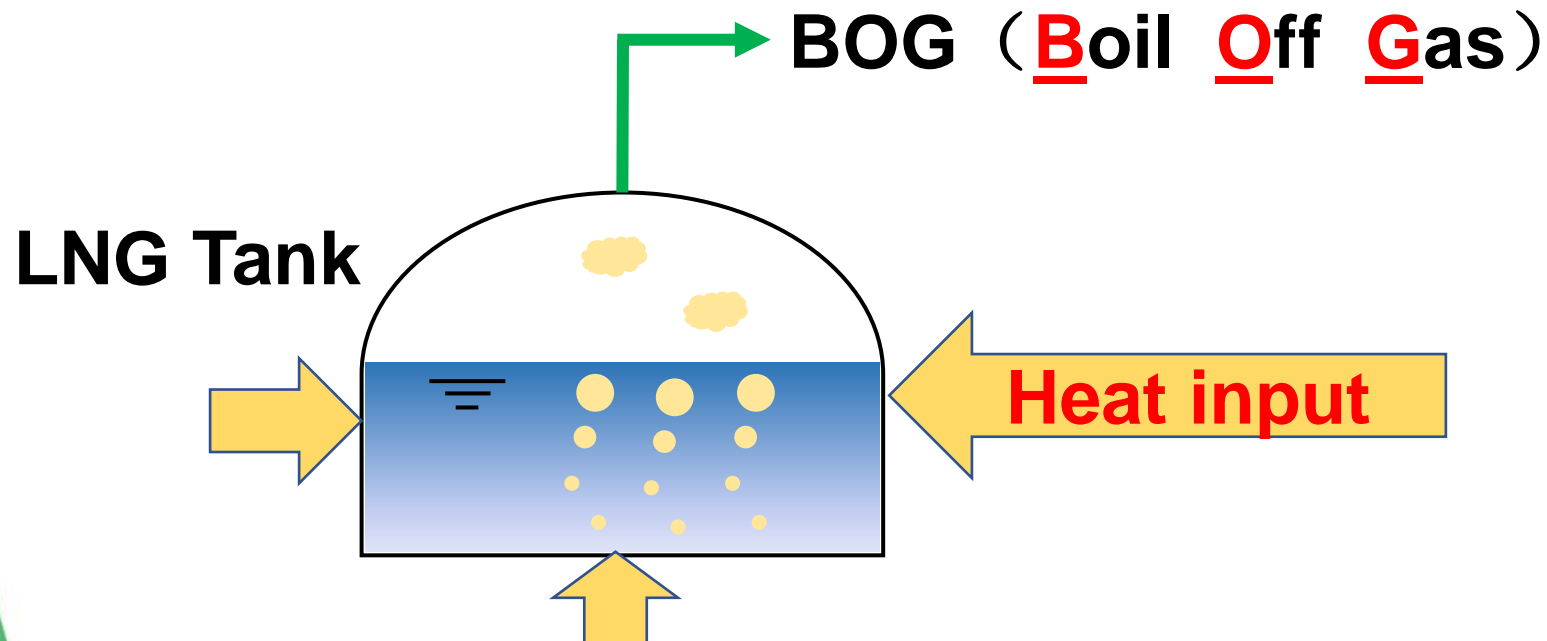


PRINCIPAL SPONSORS

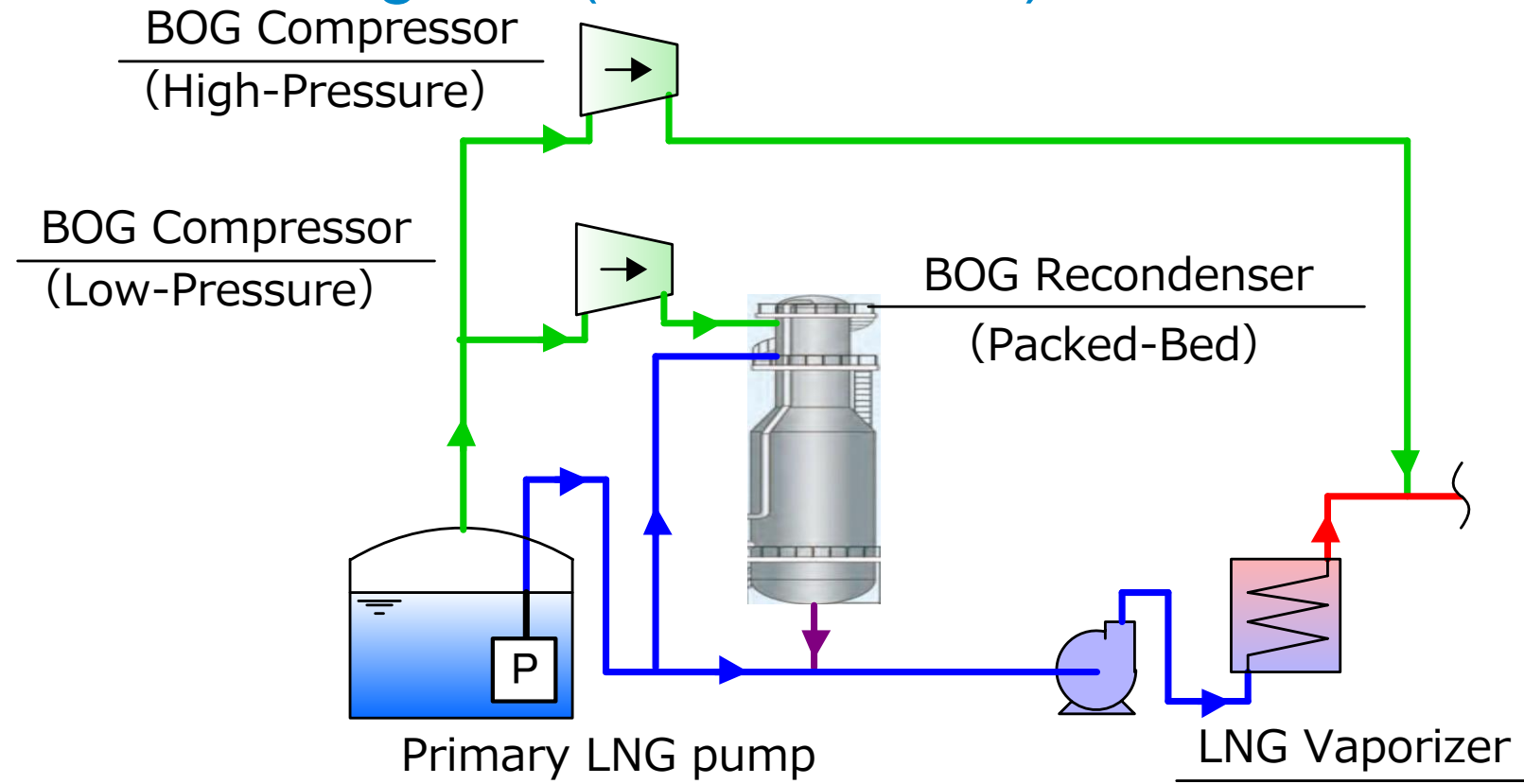


What is BOG?

- LNG is cryogenic liquid of about **-256 °F**; hence, the LNG tank subjects to heat input from outside, causing the LNG in the LNG tank to boil.
- The pressure inside the LNG tank rises because of the BOG generation; hence, BOG must be discharged from the LNG tank to keep the pressure lower than the designed pressure.



BOG Processing flow(conventional)

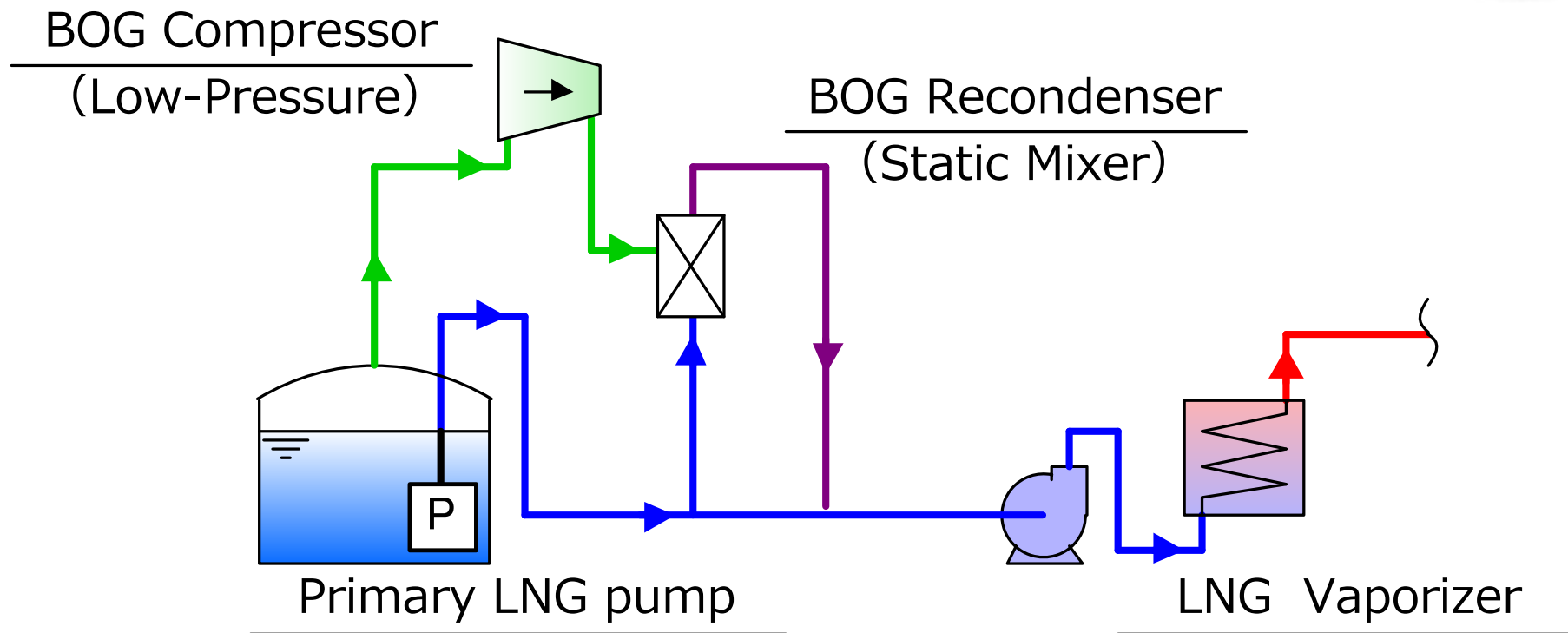


High-Pressure BOG Compressor

Packed-Bed BOG Recondenser

- **High power** consumption
- **Low power** consumption
- **Large size** and **CAPEX is high**

BOG Processing flow(Newly Developed)

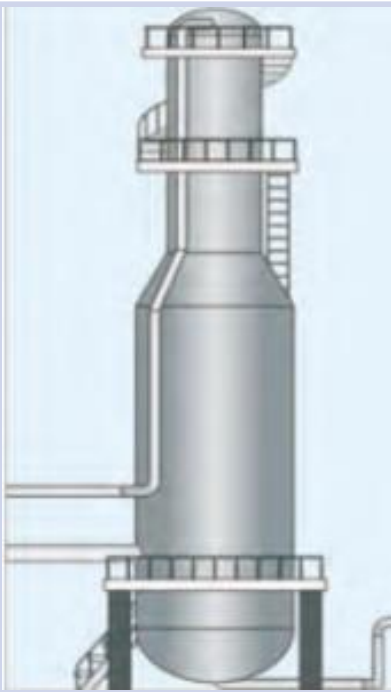
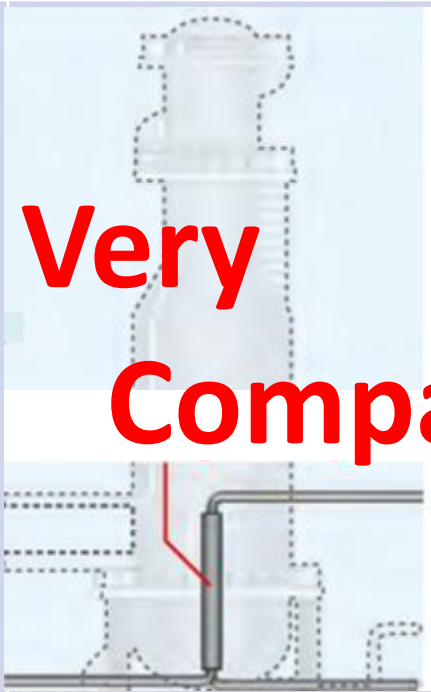


Benefits of Static Mixer type BOG recondensing system development

- It is much **smaller** and **lighter** than the conventional type
Its internal structure is **simple** and **maintenance-free**.

⇒ **Saving Space, CAPEX and OPEX**

Comparison of Recondenser

	Packed-Bed Type (Conventional)	Mixer Type (Newly Developed)
System	 <p> Length : 9.0m Diameter: 1.6m Weight : 10.0ton </p>	 <p> Length : 3.0m Diameter: 0.3m Weight : 0.7ton </p> <p>Very Compact!</p>
Volume	100% 【base】	About 2%
Weight	100% 【base】	About 7%

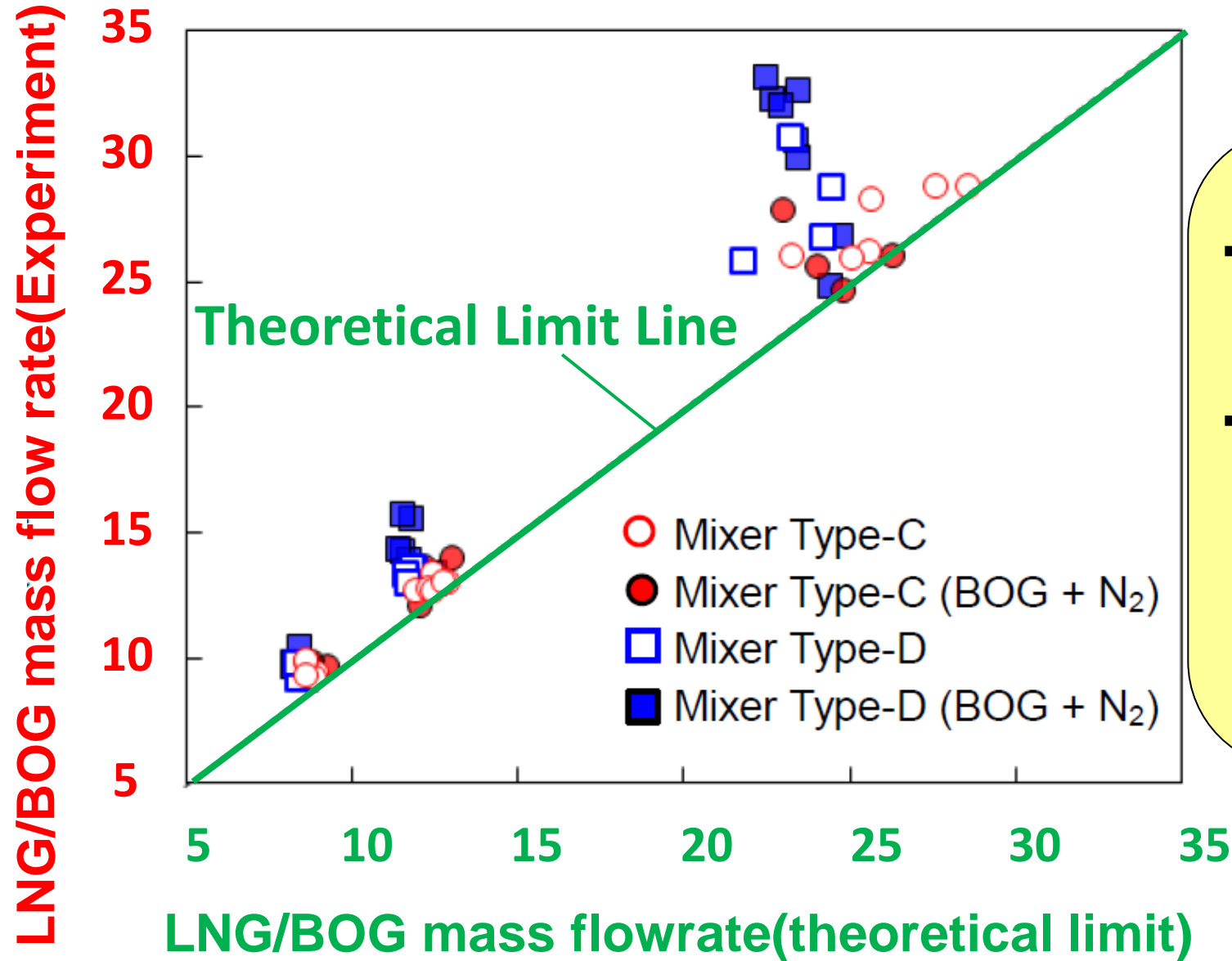
Note: Assuming a BOG Recondensing Capacity : 14t/h

Required Features

The following requirements (performance) should be satisfied for the static mixer that directly mixes BOG and LNG

No.	Requirements
(1)	Complete recondensation of the total BOG
(2)	Low pressure loss in the mixing process
(3)	Erosion prevention inside the static mixer
(4)	Durability against the temperature difference

Verification test



- No issue for scale-up from the 1/15 pilot plant
- The recondensing performance was very close to the theoretical limit.
(No influence of Nitrogen)

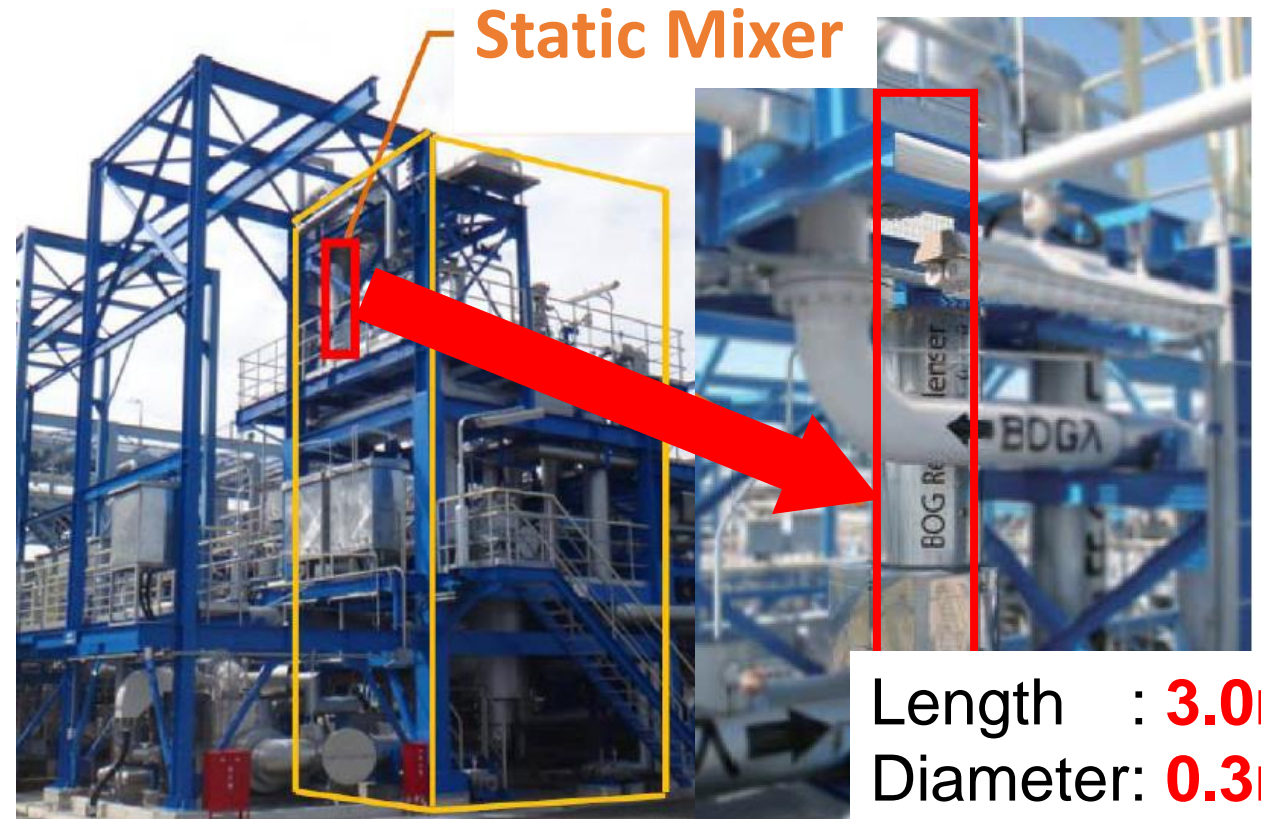
First Commercial Plant

We installed the Static Mixer BOG recondensing system



Owner : Toho Gas Co., Ltd.
 Location : Chita-Midorihamma,
 Aichi, Japan
 In operation since June , 2016

BOG Recondensing Capacity : **14t/h**



Static Mixer

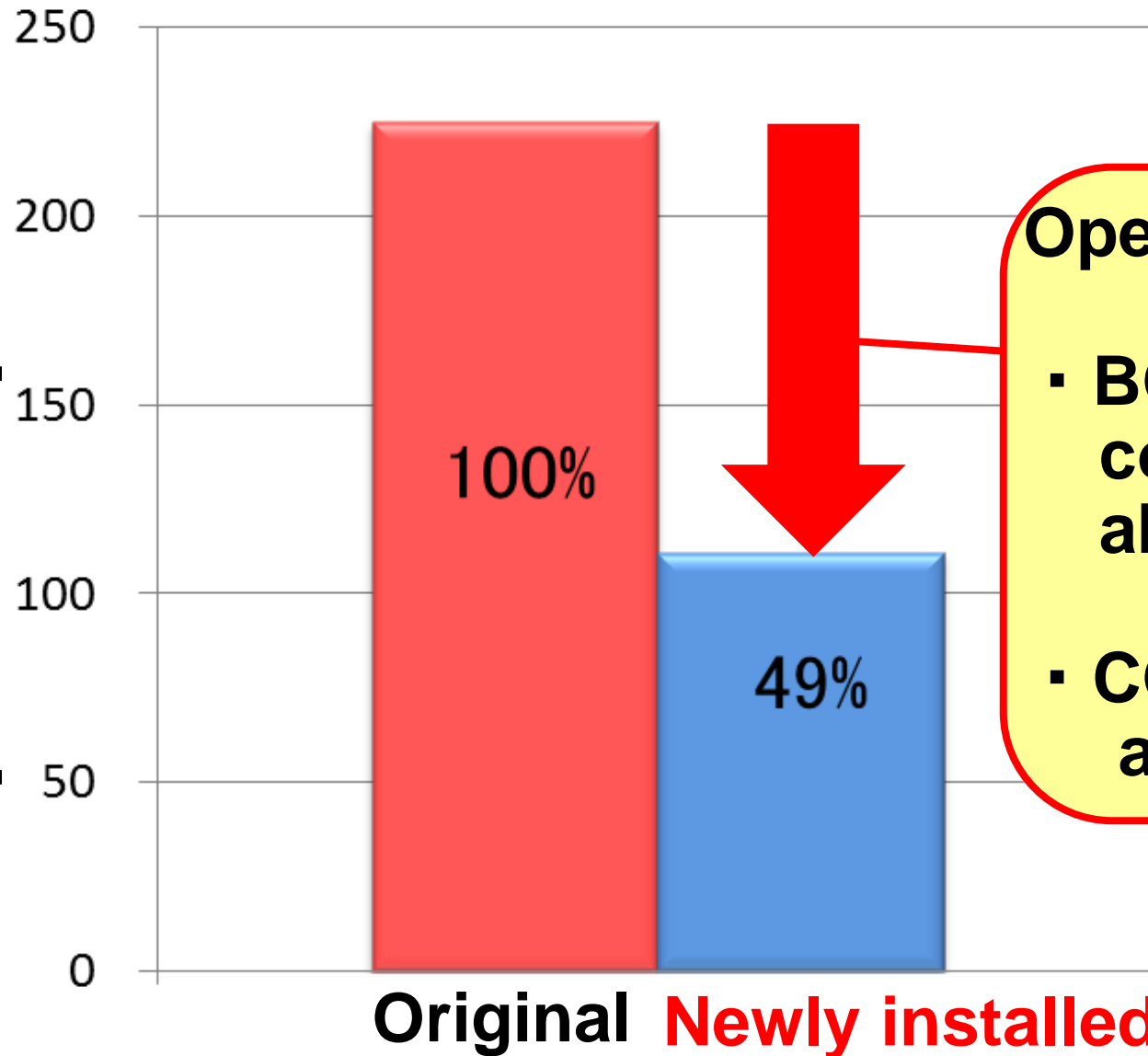
Length : **3.0m**
 Diameter: **0.3m**

Comparison between original and newly installed

	High-Pressure Compressor (Original)	Direct mixing type BOG recondensing system (Newly installed)
Equipment constitution	<p>High-Pressure Compressor x 3 units (57bar)</p> <p>High-Pressure Compressor x 1 unit (57bar)</p> <p>ORV</p> <p>LNG tank</p>	<p>High-Pressure BOG Compressor x 3 units (57bar)</p> <p>Static Mixer</p> <p>LNG pump</p> <p>Low-Pressure BOG Compressor x 1 unit (8bar)</p> <p>ORV</p> <p>LNG tank</p>
Processing capacity	14ton/h/unit	14ton/h
Processing power ratio	100 (base)	About 49%
Maintenance cost	100 (base)	About 75%

Power consumption for BOG processing

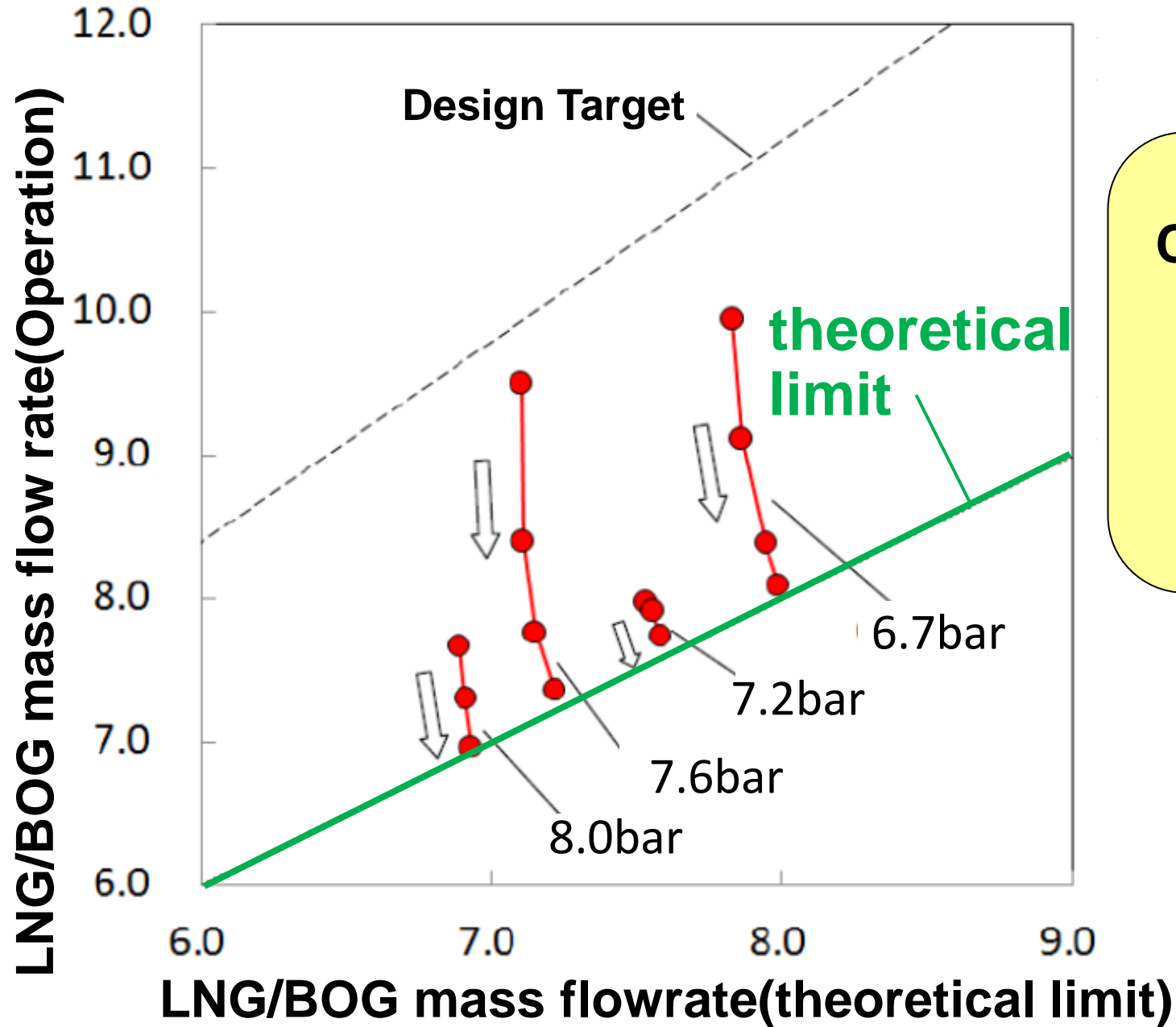
Power consumption for BOG processing
[kWh/ton-BOG]



Operational effects for 1 year

- BOG processing power consumption:
about **8,600 MWh reduction**
- CO₂ emission:
about **4,200 t reduction**

Recondensing performance



Challenged the limit

The recondensing performance is very close to the theoretical limit.

Summary

We developed Static Mixer BOG recondensing system

[Cost]

- (1) smaller and lighter**
- (2) simple and maintenance-free.**

[Equipment features]

- (1) superior recondensing performance**
- (2) Low pressure loss**
- (3) The noise and vibration are extremely low**
- (4) The short cool-down time**