1. Background of development

IHI Corporation and Tokyo Gas Co., Ltd. has jointly invented their first LNG/Liquified Natural Gas (LNG) in-tank Visualization System in the 1990s, leading ahead of others. As this system was the only way to observe inside of LNG tank without drying up. It made tremendous achievement from internal inspection of tank in operation and from observing the behavior of LNG during the receiving operation.

Although the system was epoch-making due to the practical observation under the cryogenic situation, higher performance has been awaited to observe large size LNG tanks constructed in recent years. Major problems are as below:

1. Low Resolution (Black & White vision / 300 line pixel / 5x Optical Zoom)
2. Low spec lighting unit using Halogen Lamp (70W)
3. Complicated procedures - need reinstallation. To change bottom view and side view

![Fig 1 Submersible monitoring device system adopted to tanks](image)

2. Concept and Technology

IHI, manufacturer of former system, started the development of new system aiming precise observation, include following features 1. High performance camera unit and zooming specs. 2. High performance lighting unit. 3. Simple procedure with wide observation area.

Tokyo Gas, practical user of former system, suggested the concrete development target reflecting the rich knowledge earned by past observation experience, with an advice to solve the problems in development.

Usually, to strengthen camera and lighting spec, upsizing of units is effective. However, units need to be installed to enrich spare nozzle of LNG tank and need to be easy to handle, there is a difficulty restricting the unit size as same as the former ones. (approx. size: 0.1m diameter, approx. weight: 20kg).

With a support of Tokyo Gas, IHI had worked on the issue energetically and have succeeded in the development of high-performance system, which is applicable to 250,000t-class (86m diameter) large size LNG tanks.

Technical features of development are as follows:

1. High performance camera unit and zooming specs
   Based on the technologies IHI earned from Space Exploration equipment business, new camera unit has adopted 2.1 Megapixels High-speed CMOS, strengthen zooming spec to 30x optical, and downsize the heating device and device insulation structure to fit the size.

2. High performance lighting unit
   To avoid boiling off, planned to strengthen lighting spec by examining the lighting spec in need, and adopting the low heat generated High-Luminance LED.

   To examine and optimize the lighting spec in need, IHI and Tokyo Gas jointly collected a data of transparency of light in LNG – which was world’s first attempt.

   To stabilize the illumination, unit is controlled by heater, since LED’s illumination weakens in cryogenic. High-Luminance LED is combined with condensing lens and reflectors, reducing the power consumption and heat generation from the former system.

3. Simple procedure with wide observation area
   Using Magnetic Coupling in penning and tilting rotation allied wide viewing from the bottom to the roof, without removing and reinstating from the tank.

   Adoption of the magnetic coupling reduced the risks of malfunction occurring from freezing and brining of foreign matters in rotating machinery.

   Also, downsizing of Control and Power supply Unit from the former system abled easy transportation.

3. Conclusions

The main component of newly developed system is shown in Table1, the system diagram is in Figure2, and external view of camera unit and lighting unit in Figure3.

Technical features of the system are as below:

- Small boiling off of LNG and clear vision under cryogenic (-162°C) liquid.
  *Adopting the combination of high-luminance LED with low power consumption, condensing lens, and reflectors reduced the heat generation.

- Precise observation of wide area such as the tank bottom, the inner shell laps, the roof is practicable, not depending on the tank material.

- Identify a monochrome of 10mm each side at 55m ahead, largely expanded the visual distance from the former system.

- Super zoom with 360x. (Combination of optical zoom (30x) and digital zoom (12x)).

- Easy transportation by small size an light weight.

To observe the LNG tank as a verification test of this system, confirmed the accurate action of system in cryogenic, and successfully filmed the high definition movie, and the picture which cut out the movie is in Figure4.

By using this system, precise internal inspection of tank in operation and precise observation of LNG behavior during the receiving operation is possible, and following achievements could be expected:

- Excess life diagnosis of aged cryogenic tank by precise inspection while in the operation, may enable long life time cycle of cryogenic tank.

- By observing the behavior of liquid during the receiving, development of mixing storage technique of various LNG without rolling over could help from investing extra tank.

- Achievement earned by this system is presented in poster session, titled "LNG Mixing Behaviors including Bubbles Observed During The Bottom Filling of Heavier LNG in LNG Mixed Storage". Please visit booth (#06) to learn more about it.

- Can be used in a wide range industries, since this system is practical for any low temperature liquefied gas tanks, regardless of above ground, in ground, floating or vessel.

![Table 1 Specifications](image)

![Fig 2 System Diagram](image)

![Fig 3 The devices](image)

Contact US
Those who are interested in "THE VISUALIZATION SYSTEM" and "Tank internal observation" please contact us

Shichio (FO),
Tokyo Gas Co., Ltd.
E-mail: sito@tokyo-gas.co.jp

---

**Fig 1:** Submersible monitoring device system adopted to tanks

**Fig 2:** System Diagram

**Fig 3:** The devices

**Fig 4:** Photo of observation

---

**Table 1** Specifications

<table>
<thead>
<tr>
<th>Composition</th>
<th>Camera unit</th>
<th>Illumination unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>2.1 Megapixels High-speed Color CMOS</td>
<td>30x optical</td>
</tr>
<tr>
<td>Weight</td>
<td>1.5kg</td>
<td>100x1m.2kkg</td>
</tr>
</tbody>
</table>

**Fig 2:** System Diagram

**Fig 3:** The devices

**Fig 4:** Photo of observation

---

**Contact US**

Those who are interested in "THE VISUALIZATION SYSTEM" and "Tank internal observation" please contact us

Shichio (FO),
Tokyo Gas Co., Ltd.
E-mail: sito@tokyo-gas.co.jp

---

**Table 1** Specifications

<table>
<thead>
<tr>
<th>Composition</th>
<th>Camera unit</th>
<th>Illumination unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>2.1 Megapixels High-speed Color CMOS</td>
<td>30x optical</td>
</tr>
<tr>
<td>Weight</td>
<td>1.5kg</td>
<td>100x1m.2kkg</td>
</tr>
</tbody>
</table>