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(2) Quick start-up

While the normal start-up time is ten minutes or less from issuance of the start-up command to reaching the rated load, the time is reduced to five minutes or less by using the quick start-up system, which employs compressed air to assist turbocharger rotation to maintain stable turbocharger pressure and to prevent abnormal combustion due to load increase.

(3) Wider range available in low-load operation

In response to market demand, we have expanded the available range in the low-load combustion operation from the conventional 30% load to 20% load. As a result, the ability to adjust the supply-demand balance has been improved, in addition to improved start-up performance.

(4) Support for frequency fluctuation events

The blackout caused by the Hokkaido Eastern Iburi Earthquake has increased the need to improve the tolerance to possible frequency fluctuations. To meet this challenge, we introduced a new evaluation of dynamic characteristics when the frequency drops, thus enabling all models to operate even when the frequency drops to 94% of normal, thereby contributing to stabilizing the frequency of the power grid.

(5) Establishment of 30% hydrogen mixed-fuel combustion technology

We have established a system that can appropriately control the combustion state according to the power generation output and the hydrogen mixture ratio, and we conducted hydrogen mixed-fuel combustion tests and other tests using a single-cylinder demonstration unit. As a result, we became the first Japanese gas engine manufacturer to develop a combustion technology that enables stable operation of large gas engines with a power generation capacity of 5 MW or more by mixing up to 30% by volume of hydrogen with natural gas. In hydrogen mixed-fuel combustion, safety measures against hydrogen leakage are important, so we equipped the demonstration unit with a system for safely venting any leaked hydrogen around the combustion chamber to the outside, as shown in Fig. 2.

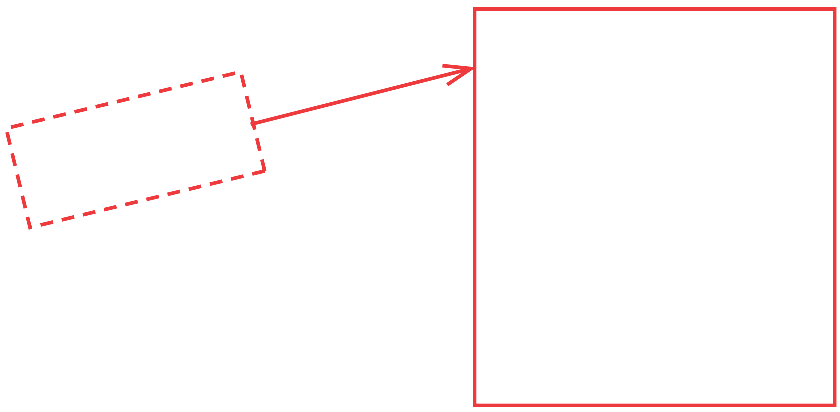

Fig. 2 Hydrogen mixed-fuel combustion gas engine for demonstration and leak detection covers

After conducting various tests on the demonstration unit, we plan to commercialize a model for hydrogen mixed-fuel combustion in 2025 and a model capable of 100% hydrogen combustion in addition to hydrogen mixed-fuel combustion in 2030. As shown in Fig. 3, 30% hydrogen mixed-fuel combustion reduces the CO_2 emission rate by about 11% compared to that of the conventional models, and 100% hydrogen combustion results in a 0% CO_2 emission rate.

Conclusion

Gas engines hav [illegible]