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Stuby on a Cabined Cycle of Gas Turbine and Refrigerating Machine

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This thesis deals with the thermodynamic analysis of combined cycle of gas turbine and refrigerating machine, and it containes five chapters.

Recently, gas turbines have highly developed and firmly established their places for the various uses of applications in the field of industry, due to their inherent advantages. However, gas turbines still have some demerits as a prime mover in comparison with steam turbines or diesel engines, that is; (1) they give fairly low value of thermal efficiency, (2) the variation of thermal efficiency and specific power are considerably large when an ambient temperature varies, and (3) thermal efficiency decreases remarkably in the part-load operation.

During the past years, a great deal of study has been done for improving those demerits of gas turbines, but it has many difficulties for practical application.

Here, this paper is intended to give a solution to these problems by adopting the new cycle concepts, which are the suction-cooling gas turbine cycles combined with refrigerating machines.

The key points of consideration for devicing the new cycle are as follows: (1), to lower the inlet temperature of the compressor (T_1) for increasing the temperature ratio $\tau = T_3/T_1$ of the cycle, (2) to use the wasted heat of the hot gas turbine exhaust effectively, (3) to bleed a part of amount of the compressed air from compressor for preventing to the turbine inlet temperature decreasing in part-load operation. Chapter one is the introduction.

In chapter two, one idea of the new cycle concepts is presented, that is; the suction-cooling gas turbine cycle combined with an air refrigerating machine by using the bleeded air. This cycle scheme is consisted of an air refrigerating machine, which is operated by using the bleeded air as a device of suction-cooling combined with the conventional gas turbine (1/C/E or 1/C/IE).

The analysis of this cycle has been performed thermodynamically for both the design point and the part-load performance. As a result, the part-load thermal efficiency of the cycle in the constant speed operation for the fixed turbine inlet temperature can be highly improved owing to applying higher air bleeding ratio.

In chapter three, the suction-cooling gas turbine cycle combined with the absortiontype refrigerating machine using the wasted heat is introduced. To increase the temperature ratio of the cycle (1/C/E), a low-temperature ammonia absorption type refrigerating machine, which is operated by using the turbine wasted heat

as a heat source to generator, is adopted as one of the cooling devices to lower intake air temperature to the compressor.

The investigation has been performed to the general thermodynamic characteristics of this combined cycle and then to find out its possibility of steady operation and the optimum condition.

As the result, it makes clear that this cycle can achieve the remarkably higher thermal efficiency and specific power than that of the gas turbine running alone.

Furthermore, the cycle has the desirable merit to lessen the variation of those values, when an ambient temperature increases.

Chapter four is a study on the total energy system of gas turbine. This system is a gas turbine powered energy plant which generates the heat output besides the shaft power, such as the practical application for electric power generation and central heating and cooling. The scheme of the cycle arrangement is the conventional gas turbine (1/C or 1/C/E) combined with the heat-recovery boiler and the lithium bromide absortion-type refrigerating machine.

From the analysis of design point and part-load performance of the system, the following result can be revealed: by recovering the wasted heat of the hot turbine exhaust and controlling the supplementary fuel and the by-pass valve of the regenerator, this system gives the fine flexibility on its operation with high thermal efficiency up to 85% over the wide range of load demand.

Chapter five is the conclusion that these new cycles described in the previous chapter are the most effective methods which can improve the demerits of the gas turbine pointed out in the beginning.