out on propane and perfluorocyclobutane fluids demonstrated that, for a maximum temperature of 400 ÷ 450 deg C, cycle efficiencies of 35 ÷ 40 percent are achievable. This makes the present cycle competitive with respect to regenerative steam cycles having similar turbine inlet temperature and pressures and with respect to closed-cycle gas turbine having maximum temperature several hundreds of degrees higher. In particular, for capacities ranging up to 10,000 kw, the present cycle could prove particularly advantageous due to the low internal efficiency of small capacity steam turbines [32].

Another field of possible application is the nuclear power industry, in which closed cycle and moderate maximum temperature are limitations imposed by the nuclear section of the plant and cannot be considered as drawbacks of the conventional power conversion station. Solar and nuclear space power systems can also offer interesting possibilities for practical application.

When fluids allowing safe operation at temperatures as high as 500 or 600 deg C become available, the liquid phase compression gas turbine will represent an alternative solution to the generalized use of steam stations for generation of basic power. As a matter of fact, under those conditions it is possible to attain cycle efficiencies of 42 ÷ 48 percent, which are comparable with the performance of the best high pressure, high temperature steam power stations [33, 34].

The use of carbon dioxide as working fluid raises a number of somewhat different problems. Thermal stability and chemical inertness are unquestioned, but only for very high turbine inlet pressures and low condensation temperatures cycle efficiencies are comparable with the best current steam practice.

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DISCUSSION

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The problem under consideration is very exciting. If the perspectives of the proposed cycle are what we have in mind, the problem of sealing seems to be of basic importance. I would thankfully appreciate any information on this particular subject.

Author's Closure

The question raised by Professor Szewalski points out one of the vital details of the cycle illustrated in my paper and I thank him for his interest. Before stating my opinion on the subject I should like to mention that there are many industries that have to cope with similar problems made more difficult by the particular nature of the fluids handled. This is the case in the nuclear industry, which employs fluids that are extremely expensive, like heavy water, or extremely fugacious, like helium.

Likewise, the chemical industry often treats chemically active, inflammable or toxic liquids and gases. More recently, the space industry and, in particular, the space power technology solved sealing problems for a particularly severe environment. Finally, the cold industry handles special fluids by means of machinery very like that required in power plants. The success in these branches of the technology makes it reasonable to hope that sealing problems can be solved also in the power generation field, in which the task is comparatively easier due to the chemical inertness and high molecular weight of the majority of the working fluids.

With respect to sealing of rotating machinery, two approaches seem the most promising. One envisages the use of canned

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machinery employing the working fluid as lubricant. This system, being of the zero leakage type, prevents any working fluid contamination by lubricating oil. Of special interest is the gas lubricated bearing, currently under development [35–37].[3] A variety of other systems employ a grazing contact. A comprehensive review of seals for special fluids can be found in reference [38]. An example of a very effective system employing a floating carbon ring is presented in reference [39]; working fluid contamination by the lubricating oil is prevented.

[3] Numbers in brackets designate Additional References at end of Closure.

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