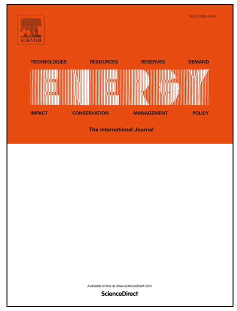
Accepted Manuscript



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PII: S0360-5442(18)31981-9

DOI: 10.1016/j.energy.2018.09.203

Reference: EGY 13897

To appear in: *Energy*

Received Date: 26 February 2018

Revised Date: 18 September 2018

Accepted Date: 30 September 2018

Multi-stage Rankine cycle (MSRC) model for LNG cold-energy power generation system

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Abstract: Power generation is the most important way to utilize LNG (liquefied natural gas) cold-energy. Currently, the efficiency of LNG cold-energy power generation is low, so it is necessary to optimize the process. On the other hand, the requirements of refrigerants for different LNG cold-energy power generation cycles are different. Thus, improper selection of refrigerant can increase exergy loss and decrease the cold-energy utilization. In view of these two aspects, this paper makes a deep research on conventional refrigerants for low-temperature Rankine cycle (RC), the refrigerant selection principle of RC is determined. Based on the study of the LNG cold-energy release law and its gasification characteristics, LNG cold-energy power generation multi-stage utilization model is established. On the basis of the newly established model, the existing process is improved (this paper takes the five-stage RC power generation process as an example). The effects of gasification pressure, seawater temperature and stage number on the system are analyzed. The advantages of the multi-stage Rankine cycle (MSRC) are evaluated from the exergy recovery rate (ERR), LNG cold-energy utilization and net power generation (NPG). The main conclusions can be obtained: (1) compared with the single-stage RC, the ERR, cold-energy utilization, cold-exergy utilization and net power generation (NPG) of the five-stage RC are much higher. (2) under subcritical pressure conditions, the NPG of the first-stage cycle and the second-stage cycle accounts for the majority of the entire system NPG. (3) the difference in NPG between the two stages in the “supercritical pressure” grading system is not significant. (4) as the stage number of MSRC increases, the growth rate of NPG gradually slows down.

Keywords: LNG (liquefied natural gas); Cold-energy power generation; Refrigerant; Multi-stage Rankine cycle (MSRC); Exergy; Net power generation (NPG)

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