ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 2, Issue 10, October 2013

E.G.N (Entransy gain number) as an Optimizing Parameter for Working Fluids in Various Work Generating Cycles

Sushant Puanik, Anuj Mamodiya

Abstract— **As fossil fuels are gradually depleted, fuel prices will surely rise. As a result, energy shortages are foreseen as a detrimental factor that could restrict economic and social development. Improving energy use efficiency is one of the most effective ways to address an energy crisis. We in our study are introducing a new concept which can be defined as "entransy gain number" which can be utilized as an optimizing parameter for working fluid at inlet of the work generating system to increase its performance. A new physical quantity entransy has been identified as a basis for optimizing various processes in terms of the analogy between heat and electrical conduction. This query which will be referred to as entransy corresponds to electrical energy stored in capacitor. Although introduction of concept of entransy has been shown advantages in heat exchangers, it is still unexplored and needs to be studied. Conventionally in all work generating systems/cycles viz. open cycle gas turbine/ closed cycle gas turbine(Brayton Cycle), steam turbine(Rankine cycle), spark ignition combustion engine(Otto cycle), compression ignition combustion engine(Diesel cycle) we focus on the process of work extraction rather than optimizing heat addition. In this paper a method is suggested that by maximizing the entransy at the start of the work generating process the performance of the system can be definitely enhanced.**

Index Terms— Entransy, efficiency, temperature, work generating device.

I. INTRODUCTION

The present work, based on expressions of entransy gain from heat conduction under finite temperature rise and flow with finite pressure rise and on certain mathematical methods to maximize the rise of entransy. The transfer of energy, momentum and mass are three main forms of transport phenomena in the nature or engineering. Energy takes many forms, such as thermal energy, sound energy, mechanical energy, optical energy etc. When energy in any form other than thermal energy is transferred, a part of it will be transformed into thermal energy, and when thermal energy is transferred, a certain amount of it will lose or dissipate somewhere. This is the so-called irreversibility of energy conversion and transport processes. Therefore, in order to reduce the irreversibility of heat transfer process, it is necessary to explore its physical mechanism and optimize the process by quantitatively analyzing the changes of physical quantities and recording the traces left by these changes.

Sushant Puranik, Mechanical Department *SIM.S Indore Indore, India,+919406628463*
Anuj *Mamodiya,* ***Mechanical Department,*** *IIST Indore, Indore, India,+919993172219.,*

II. ANALYSIS

If before heat/work addition the working fluid is at state 1 and after heat and or work addition the working fluid is at state 2.
Let the temperature of fluid at state 1 is T_1
Let the pressure of fluid at state 1 is P_1
Let the temperature of fluid at state 2 is T_2
Let the pressure of fluid at state 2 is P_2
Entransy rise due to temperature change is

$$\Delta E_T = \frac{1}{2} m` C_p (T_2^2 - T_1^2)$$

Entransy rise due to pressure is

$$\Delta E_P = \frac{m`(P_2-P_1)(T_2-T_1)}{\rho \ln(\frac{T_2}{T_1})}$$

Total entransy rise is

$$\Delta E = \Delta E_T + \Delta E_P$$

$$\Delta E = \frac{m` C_P (T_2^2 - T_1^2)}{2} + \frac{m`(P_2-P_1)(T_2-T_1)}{\rho \ln(\frac{T_2}{T_1})}$$

As we know that the various parameters viz. pressure(P_1) and temperature(T_1) at the inlet of the work generating devices i.e. at state 1 are considered to be constant and further mass flow rate(m`) and specific heat (C_P) are also invariable parameters; thus the only variable quantities that remain are pressure(P_2) and temperature(T_2) at the exit i.e. at state 2.
For maximizing the total entransy rise we have to differentiate the above expression with respect to T_2.
Keeping pressure at the exit i.e. P_2 constant temperature at the exit i.e. T_2 can be evaluated by differentiating the above equation with respect to exit temperature T_2 viz.

$$\frac{d(\Delta E)}{dT_2} = \frac{m` C_P}{2}[2T_2] + \frac{m`(P_2-P_1) * \left[ln\frac{T_2}{T_1}\right] * 1 - (T_2-T_1)\frac{T_1}{T_2} * \frac{1}{T_1}}{\left[ln\frac{T_2}{T_1}\right]^2} = 0$$

$$C_p T_2 + \frac{(P_2-P_1)}{\rho} * \frac{1}{\left[ln\frac{T_2}{T_1}\right]^2} * \left[ln\frac{T_2}{T_1} - 1 + \frac{T_1}{T_2}\right] = 0$$

$$\left[ln\frac{T_2}{T_1}\right]^2 C_p T_2 + \frac{\Delta P}{\rho} * \left[\frac{T_1}{T_2} + ln\left(\frac{T_2}{T_1}\right) - 1\right] = 0$$

By solving the above equation and finding the value of T_2 for a predefined value of P_1, T_1, and P_2.

In this manner for that value of T_2 we will have maximum entransy at state 2 i.e. at exit which in turn will yield more power output and efficiency.

III. CONCLUSIVE REMARKS

From our generalized study of work generating cycles, it can be concluded that the entransy (an emerging term in the field of thermodynamics) can become an optimizing parameter for determining the efficiency and power output of the work generating system which can be an engine or a turbine.
This study is generalized one and definitely needs further research and investigation in any specific direction. This paper only suggests a way/method to increase the performance of a work generating system.
This paper might become advantageous in improving performance of the work generating system or further research in the same field.

REFERENCES

[1] Li XueFang, GUO jiang Feng, XU MingTian and CHENG Lin (2011),entransy dissipation minimisation of heat exchanger design, *Chinese science bulletin*,**56**,20,pg 2174-pg2175.

[2] M.Thiromaleswar,(2006),*fundamental of heat and mass transfer*, Pearson education,India.

[3] W.Liu, Z.C.Liu, H.Jia, A.W.Fan,A. Nakayama (2011), *entransy expression of the second law of thermodynamics and its application to optimisation in heat transfer proceses*,**54,***13-14,pg3049-pg3050.*

[4] Zeng-Yuan Guo, Hong-Ye Zhu and Xin-Gang Ling (2006),Entransy-A physical quantity describing heat transfer ability, *international journal of heat and mass transfer*,**50,***13-14* pg2545-pg2546.

Sushant Puranik

Education

- Bachelor of engineering in Industrial Production Engineering, from S.G.S.I.T.S., Indore, affiliated to R.G.P.V. in December 2010 with a degree of 77.8%.

Experience

- At present working in the S.I.M.S.(Indore)
- Worked as Assistant professor in Medicaps institute of technology & management engineering college from 1/2/2012 to 15/6/2012.
- Worked as a lecturer in Indore institute of science & technology (I.I.S.T.) from 17/2/2011 to 31/1/2012

Special Achievements

- Achieved All India rank 5th in GATE 2010 in Industrial production engineering with 99.8 percentile.a
- Achieved All India rank 54th in GATE 2011 in Mechanical engineering with 99.93 percentile.
- Achieved 1st rank in diploma.
- Throughout all clear
- Successfully cleared the written exam of I.E.S.2010 with Mechanical branch. .
- Successfully cleared the written exam of N.T.P.C. with Mechanical branch. .
- Successfully published a research paper named “Experimental analysis of entransy dissipation number as performance parameter for heat exchanger” in International conference on “advances in mechanical, automobile and aerospace engineering” (AMAAE-2013) Organized by “krishi sanskriti” On 21st – 22nd September 2011Jawaharlal Nehru university

Anuj Mamodiya

Education

- Pursuing Bachelor of engineering in Mechanical Engineering from IIST