

## Numerical study on the performance of a novel two-stage indirect evaporative /thermoelectric cooling system

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### 1. Abstract

In the IEC-TEC system, the outdoor air is pre-cooled in the first stage cross-flow regenerative IEC and then further cooled in the second stage TEC. The mathematical models of the system is built to investigate the system's performance and its main influential parameters. It is found that the COP of the IEC-TEC system decreases with the increase of TEC module number  $n$ , electrical current  $I$  and inlet primary air humidity  $RH_{p,i}$ , and the decrease of inlet primary air temperature  $T_{p,i}$ .

### 2. IEC/TEC system description

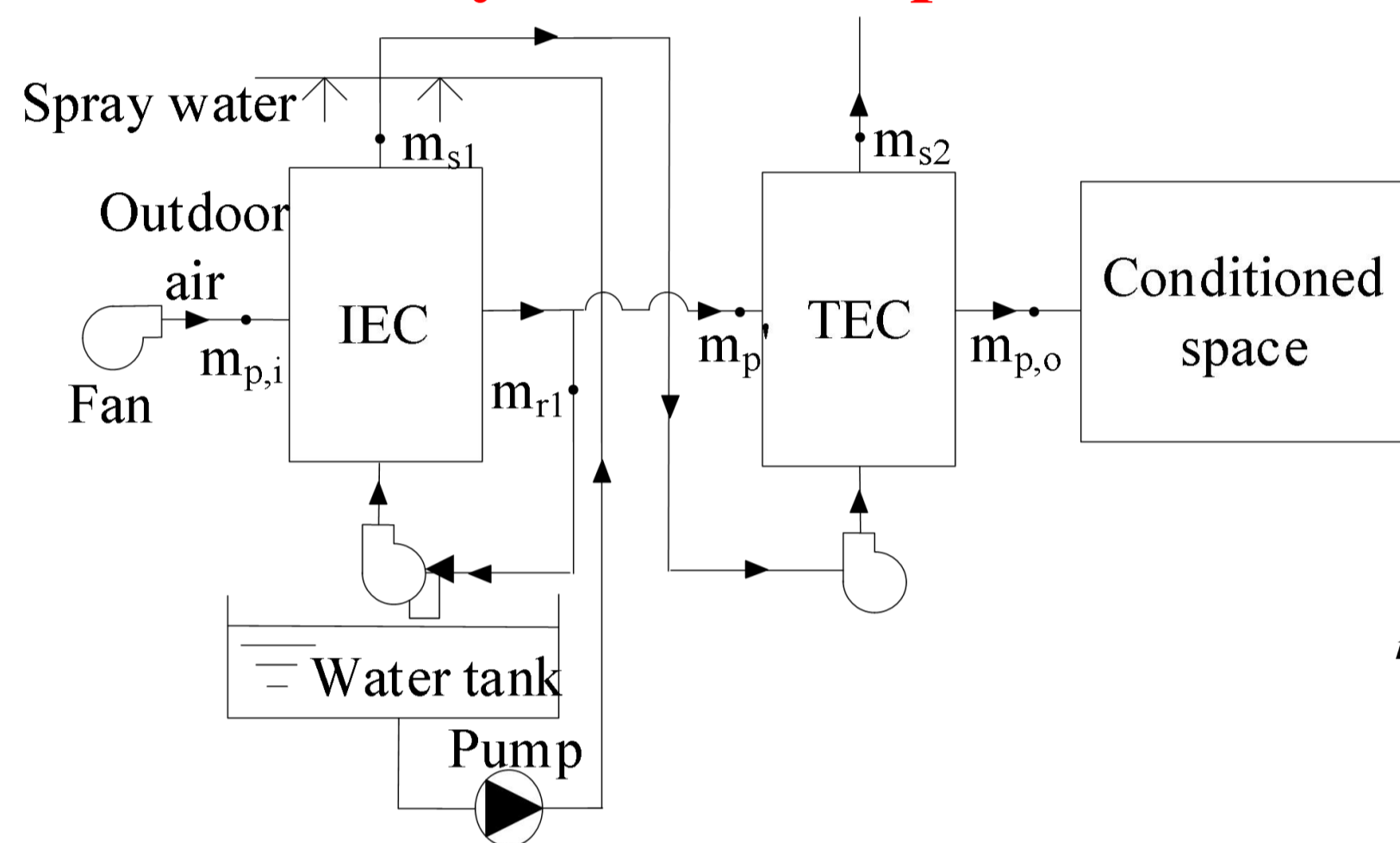


Fig.1. Schematic diagram of the two stage IEC/TEC system

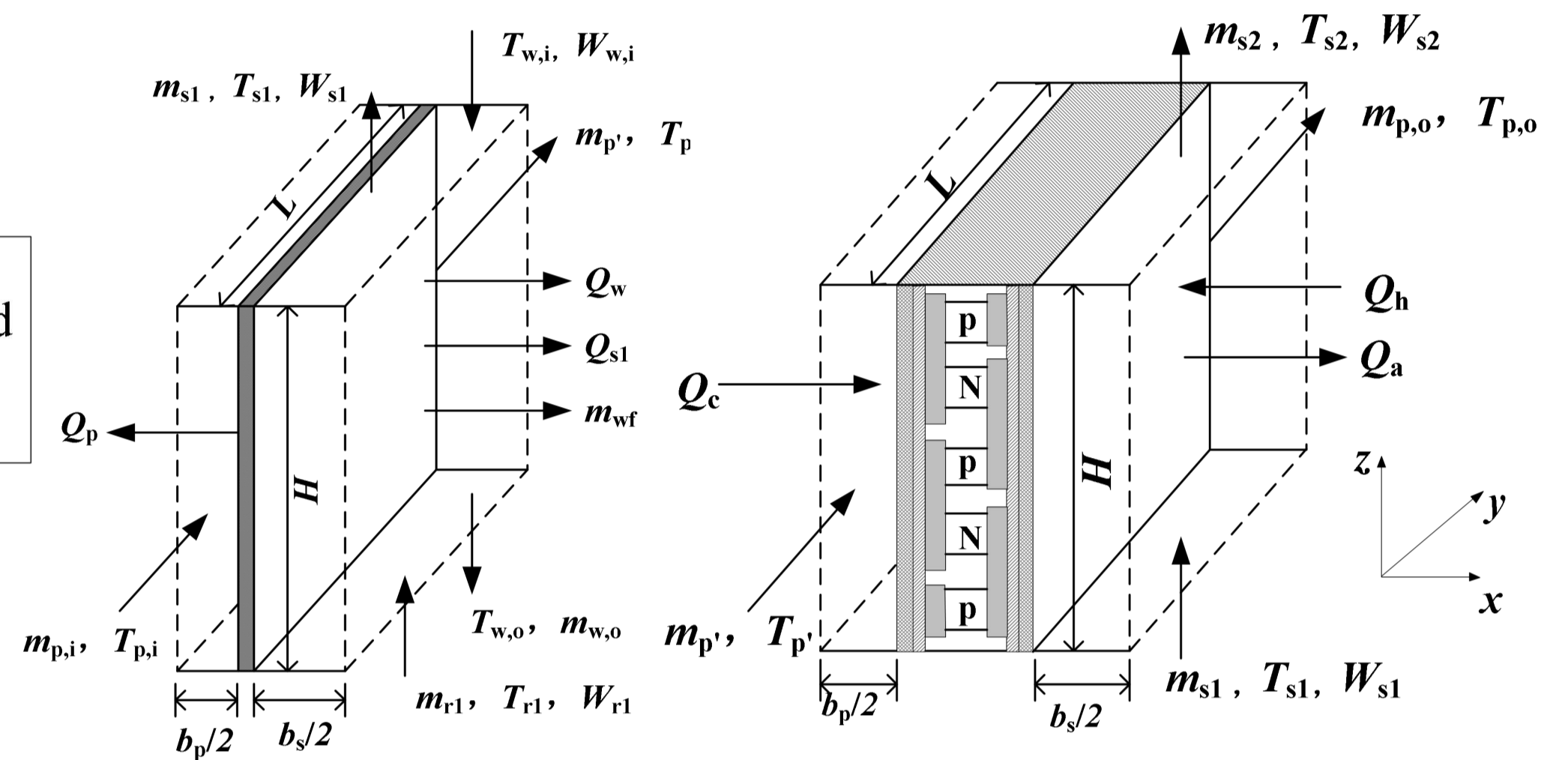


Fig.2. Control volumes of the IEC/TEC cooler.

The TEC modules is located between the primary air channel and the secondary air channel. The cold sides are connected with the primary air channel to re-cool the primary air. The hot sides are connected with the secondary air channel, and the heat released from the hot sides is absorbed by the secondary air.

### 3. Results and discussion

Table 1. Ranges of main operating parameters for theoretical study

Parameters	Value	Parameters	Value
$T_{p,i}$	25-40°C	$I$	0.5A, 1A
$RH_{p,i}$	30-80%	$n$	8, 12
$v_{p,i}$	0.8~2.4m/s		

### 4. Conclusion

(1) By increasing the electric current  $I$ , the number of TEC modules  $n$  and the primary air inlet relative humidity  $RH_{p,i}$ , and reducing the primary air inlet temperature  $T_{p,i}$ , the COP of the IEC-TEC system gradually decreases. With the increases of  $I$ ,  $n$ ,  $T_{p,i}$  and  $RH_{p,i}$  and decrease of the primary air inlet velocity  $v_{p,i}$ , the dew point efficiency increases gradually.

(2) A maximum COP can be obtained by optimizing the primary air inlet velocity  $v_{p,i}$ .

(3) Higher electric current  $I$ , number of TEC modules  $n$ , primary air inlet temperature  $T_{p,i}$ , relative humidity  $RH_{p,i}$  and lower primary air inlet velocity  $v_{p,i}$  will promote the occurrence of primary air condensation, and realize the cooling and dehumidification of air.

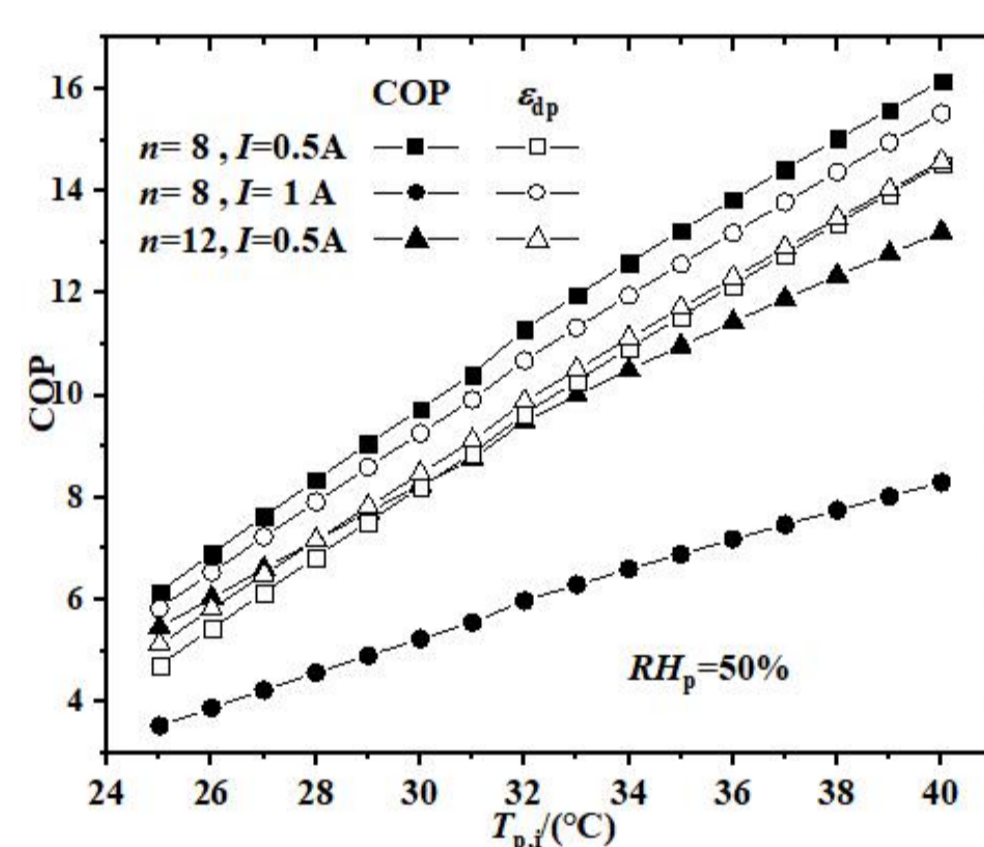


Fig.3. COP and  $\epsilon_{dp}$  versus  $T_{p,i}$

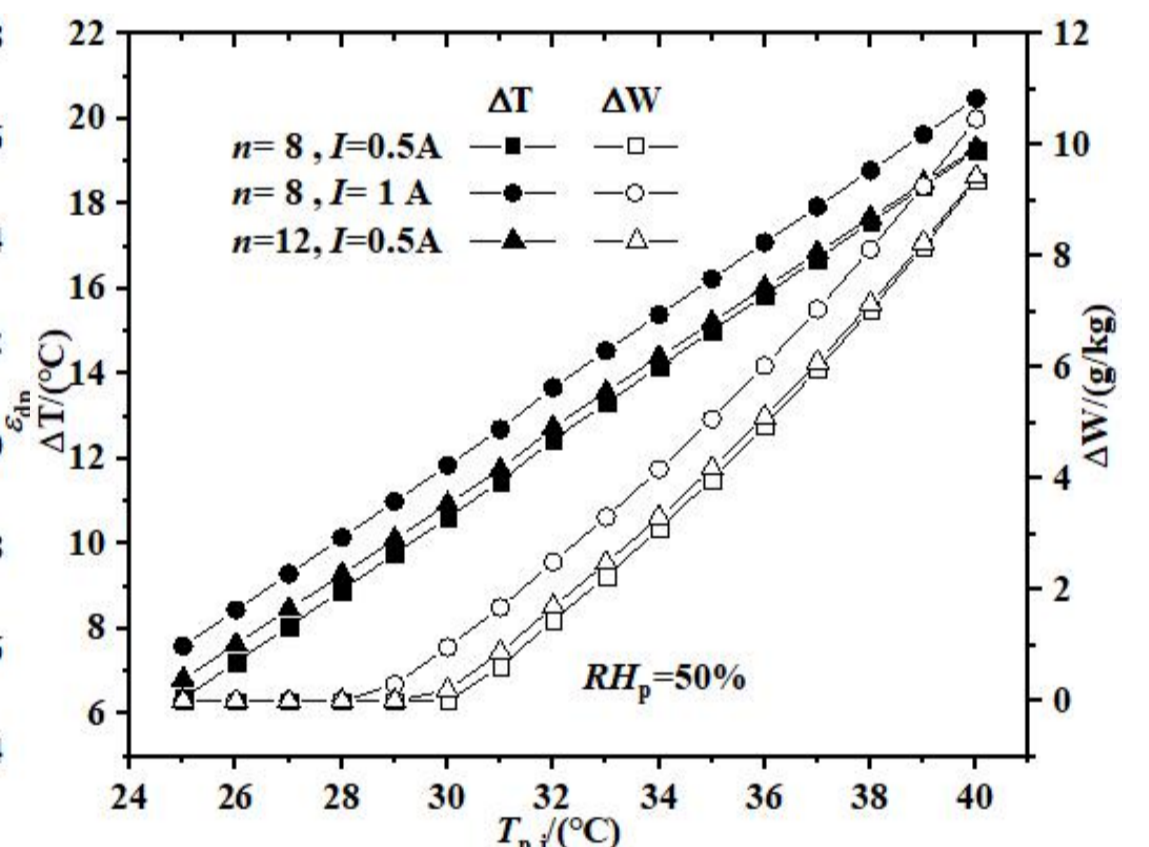


Fig.4.  $\Delta T$  and  $\Delta W$  versus  $T_{p,i}$

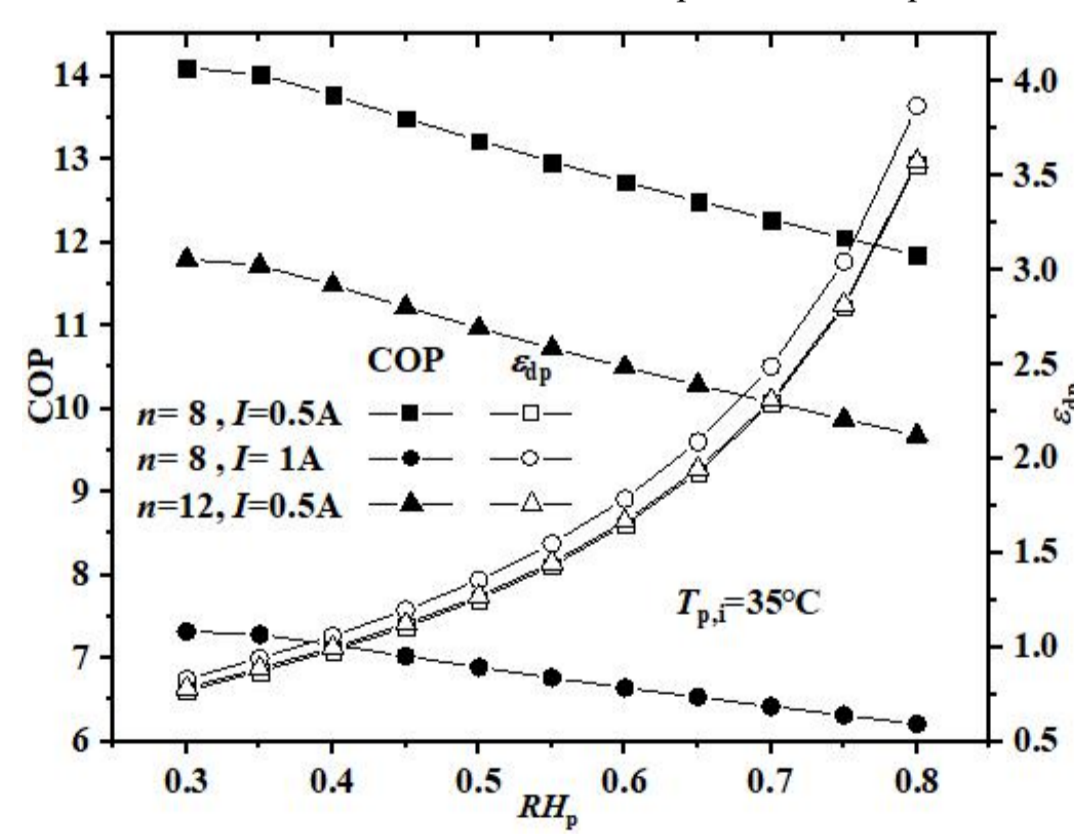


Fig.5. COP and  $\epsilon_{dp}$  versus  $RH_{p,i}$

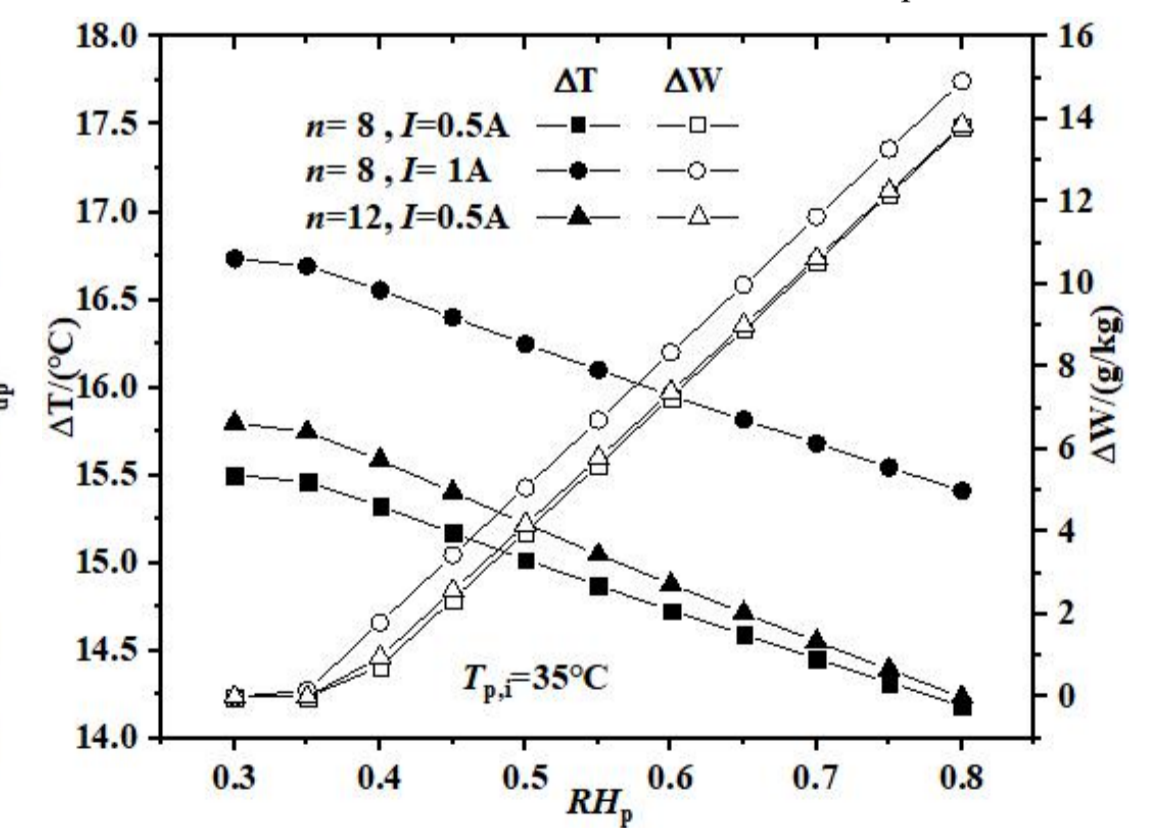


Fig.6.  $\Delta T$  and  $\Delta W$  versus  $RH_{p,i}$

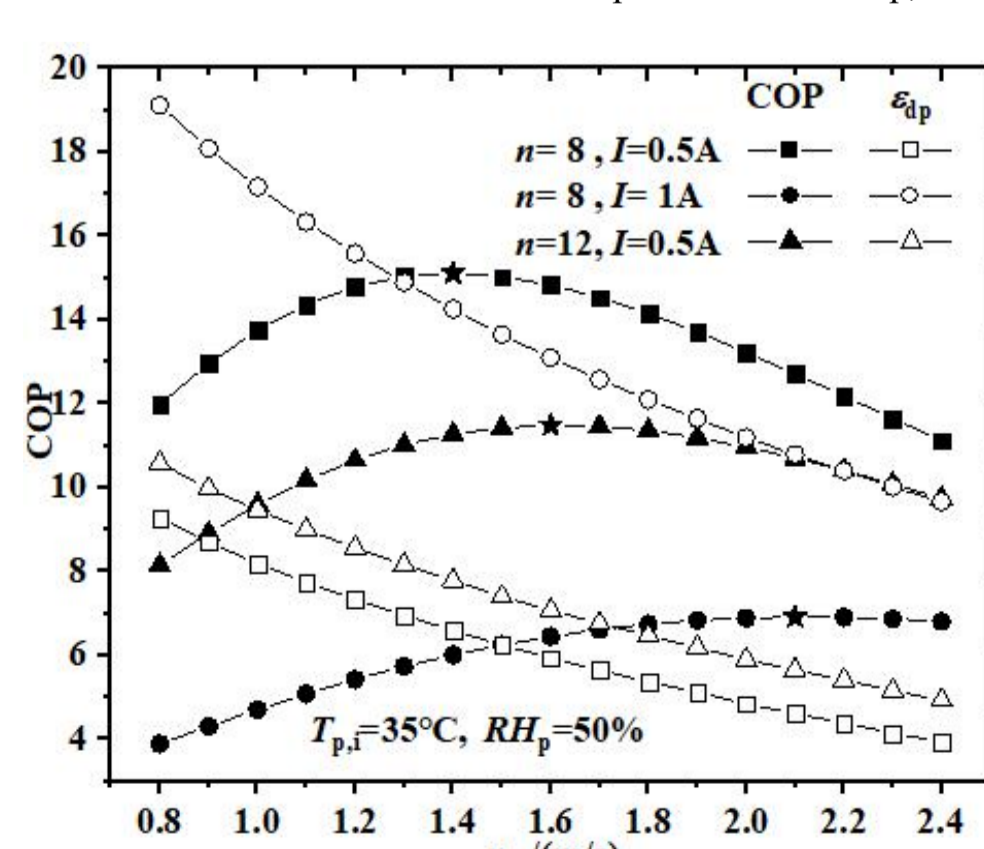


Fig.7. COP and  $\epsilon_{dp}$  versus  $v_{p,i}$

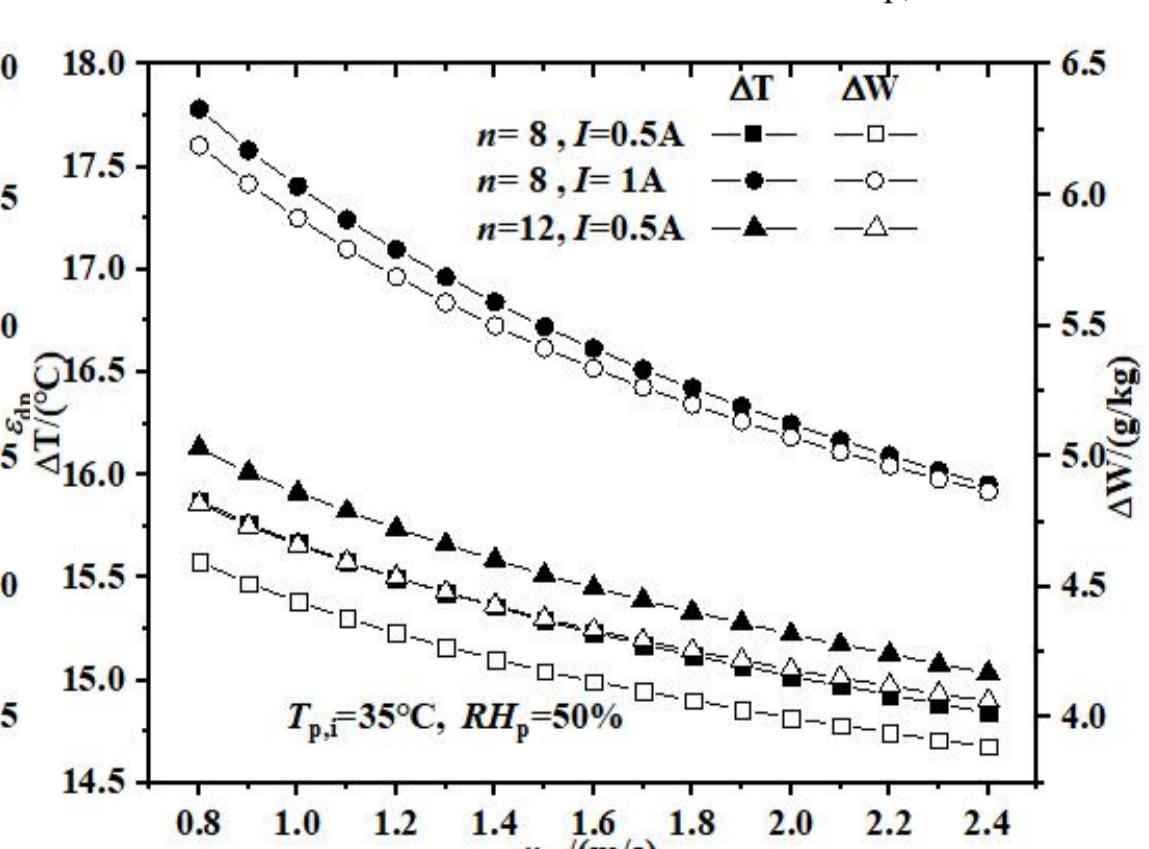


Fig.8.  $\Delta T$  and  $\Delta W$  versus  $v_{p,i}$