KOREA INSTITUTE OF ENERGY RESEARCH

Hybrid modeling based interpretation for a hydrogen recirculation system of an automotive PEMFC system

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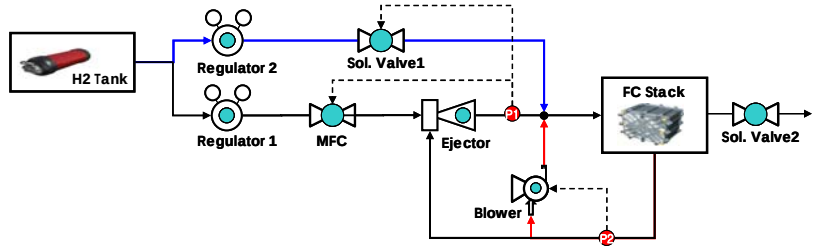
Introduction

- **Advantages of the ejector/blower based fuel cell recirculation system**
  - → Reduction of the parasitic power
  - → Higher efficiency for the fuel cell system
  - → Acceptable operating range is widen
- **Research objective**

  Dynamic modeling of the ejector/blower hybrid fuel recirculation system for PEMFC

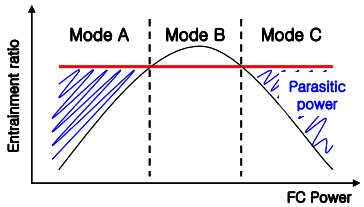
Target system

- **Ejector/blower hybrid recirculation system**



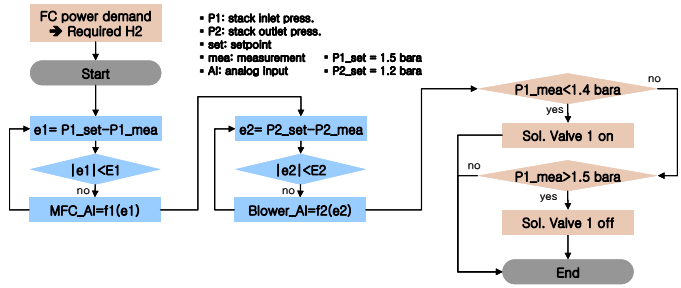
Computer-aided simulation

- **Operating modes of the hybrid recirculation system**



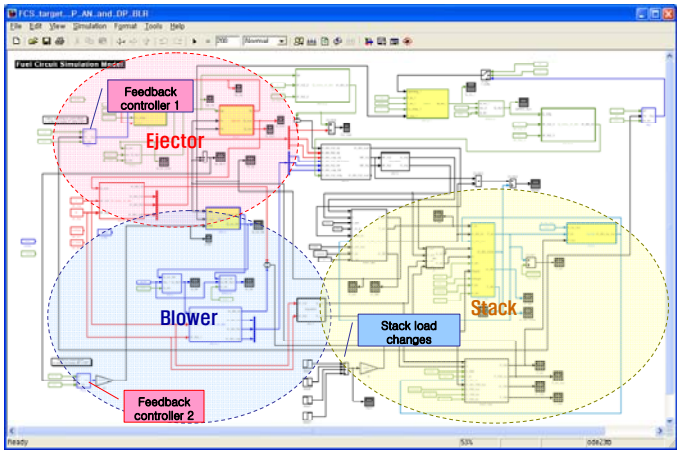
Mode	Main control	부 제어
A	Ejector control by MFC	Blower rpm control
B	Ejector control by MFC	Blower off
C	Ejector control by MFC	Blower rpm control

- **Control logic of the hybrid recirculation system**

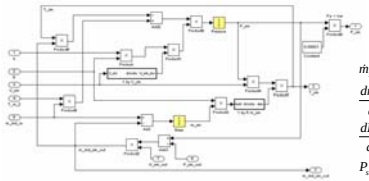


Dynamic modeling

- **Fuel circuit dynamic model including the controller**



- **Supply manifold**



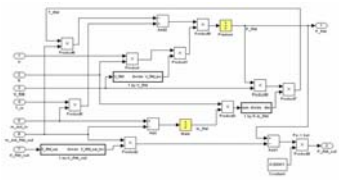
$$\dot{m}_{sm\_out} = K_{sm\_out}\left(P_{sm} - P_{sm\_out}\right)$$

$$\frac{dm_{sm}}{dt} = \dot{m}_{in} - \dot{m}_{sm\_out}$$

$$\frac{dP_{sm}}{dt} = \frac{kR}{V_{sm}}\left(\dot{m}_{in}T_{in} - \dot{m}_{sm\_out}T_{sm}\right)$$

$$P_{sm}V_{sm} = m_{sm}RT_{sm}$$

- **Return manifold**



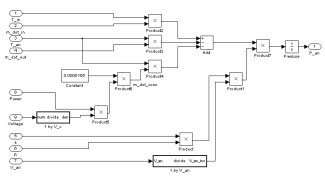
$$\dot{m}_{RM\_out} = K_{RM\_out}\left(P_{RM} - P_{RM\_out}\right)$$

$$\frac{dm_{RM}}{dt} = \dot{m}_{in} - \dot{m}_{RM\_out}$$

$$\frac{dP_{RM}}{dt} = \frac{kR}{V_{RM}}\left(\dot{m}_{in}T_{in} - \dot{m}_{RM\_out}T_{RM}\right)$$

$$P_{RM}V_{RM} = m_{RM}RT_{RM}$$

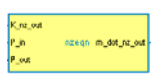
- **Anode of the fuel cell stack**



$$\frac{dP_{an}}{dt} = \frac{kR}{V_{an}}\left(\dot{m}_{in}T_{in} - \dot{m}_{out}T_{an} - \dot{m}_{cons}T_{an}\right)$$

$$\dot{m}_{cons} = 1.05*10^{-5}\frac{P_c}{V_c}$$

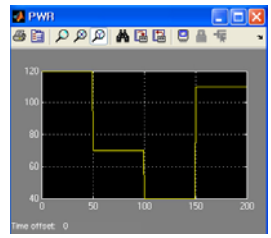
- **Anode outlet flow rate**



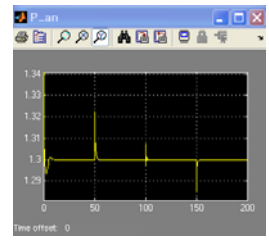
$$\dot{m}_{nz\_out} = K_{nz\_out}\left(P_{in} - P_{out}\right)$$

Dynamic simulation results

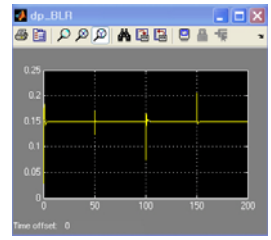
- **Disturbance**
  - → FC power demand



- **Response variable 1**
  - → anodic press. (1.3 bara)



- **Response variable 2**
  - → DP in channel (0.15 bara)



Conclusions

- **Development of the dynamic model for the ejector/blower hybrid recirculation system**
  - → analysis the system's dynamic behavior
  - → design its controller
- **Help to improve the system's performance**
  - → acceptable operating range is widen
  - → system efficiency is improved