Development of a virtual reality education program for hydrogen fueling station

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For the purpose of assessing impacts on people inside and outside a station, it is significant to understand the general hydrogen properties, the function and use of the facilities, and possible accident scenarios.
Hydrogen Safety Problems

What is the risk, and how to minimize it, in connection to new infrastructure, filling, production, and storage?

Which questions must be answered regarding hydrogen safety?

- What if hydrogen leaks inside a congested process facilities?
- How to optimize wall strength and vents?
- How to design ventilation system in leak-exposed buildings?

What if there is a significant leak in a car commercial or transport vehicle?

How to dimension a container or pipes with flammable H₂-air?
Hydrogen Fueling Station

Fueling Station Type

On-Site Type
- Steam Reforming Production
  - Naphtha, LPG, LNG
- Electrolyze Production
  - Water
- Compressed Hydrogen Delivered
- Gas
- Liquid Hydrogen Delivered
  - Liquid, Vaporizer

Off-Site Type
- Compressed Hydrogen Delivered

Compressed Hydrogen Delivered

Components:
- Reformer
- Compressor
- Storage
- Dispenser
- ESD
- Breakaway
- Leak Monitor
- Vent
Hydrogen Station Simulator

Hydrogen as a Energy Carrier
- Hydrogen Economy
- Property
- Safety Problems
- Hydrogen Station
- ERP/SOP

Virtual Reality Experience
- Virtual Reality Experience Using 3D Technology
- 8 Type Hydrogen Stations in KOREA

Accident Scenario Simulation
- 61 Different of Accident Scenario
- Dynamic Simulation
- Trainee can understand and practice these processes indirectly. The trainee can easily find the necessary information with user-friendly GUI consisting menu, command buttons, selection boxes, icons, and so on.

- A simulator is developed regarding eight types hydrogen stations, station types are city gas reforming method, LPG reforming method, naphtha reforming method, compressed hydrogen gas delivery method, electrolysis method, kerosene reforming method, hybrid method and liquid hydrogen delivery method.
Type of Hydrogen Fueling Station

NATURAL GAS REFORMING TYPE

LPG REFORMING TYPE

NAPHTHA REFORMING TYPE

COMPRESSED GAS DELIVERY TYPE
Type of Hydrogen Fueling Station

- **Electrolysis Type**
- **Kerosene Reforming Type**
- **Hybrid Type**
- **Liquid Hydrogen Delivery Type**
The virtual reality experience module displays hydrogen fueling station facilities (HDS, Reformer, WGS, PSA, Compressor, Storage, Dispenser, Control Office, Fuel Cell Vehicle, etc.) and safety equipment (Emergency Shutdown Device, Vent Stack, Protective Wall, Leakage Detection System, Programmable Logic Controller, etc.).
Animation Event of Emergency Safety Device

Breakaway event animations

Leak detection sensor animations
- Trainee can select main facility (producer, compressor, storage and dispenser) and view them from various angles by rotating scale up and down.

**Object View**
 Accident Scenario Module

- A dynamic simulation is conducted by commercialized CFD program developed hydrogen accidents model.
- A movie or animation file offers the simulation results could easily understand hydrogen station accidents.
### Examples of Accident Scenarios

<table>
<thead>
<tr>
<th>ScA.</th>
<th>Accident</th>
<th>Location</th>
<th>Cause</th>
<th>Scale</th>
<th>Leak direction</th>
<th>Wind</th>
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<tbody>
<tr>
<td>1</td>
<td>Leak</td>
<td>Dispenser</td>
<td>Operator Miss</td>
<td>Small</td>
<td>+Y</td>
<td>No</td>
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<tr>
<td>2</td>
<td>Leak</td>
<td>Dispenser</td>
<td>Mechanical failure</td>
<td>Small</td>
<td>+Y</td>
<td>No</td>
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<tr>
<td>3</td>
<td>Leak</td>
<td>Dispenser</td>
<td>Safety device failure</td>
<td>Large</td>
<td>+Y</td>
<td>No</td>
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<tr>
<td>4</td>
<td>Leak</td>
<td>Dispenser</td>
<td>Car crash</td>
<td>Large</td>
<td>+Y</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
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<td>Dispenser</td>
<td>Mechanical failure</td>
<td>Small</td>
<td>+Z</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Leak</td>
<td>Dispenser</td>
<td>Mechanical failure</td>
<td>Small</td>
<td>+Y</td>
<td>No</td>
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<tr>
<td>7</td>
<td>Explosion</td>
<td>Dispenser</td>
<td>Hose corrosion</td>
<td>Small</td>
<td>+Y</td>
<td>5m/s</td>
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<td>8</td>
<td>Explosion</td>
<td>Dispenser</td>
<td>Rupture due to mechanical failure</td>
<td>Large</td>
<td>+Y</td>
<td>No</td>
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<td>9</td>
<td>Explosion</td>
<td>Dispenser</td>
<td>Overpressure(400bar)</td>
<td>Small</td>
<td>+Y</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>Explosion</td>
<td>Storage</td>
<td>Overpressure(700bar)</td>
<td>Large</td>
<td>+Y</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>Explosion</td>
<td>Storage</td>
<td>Overpressure(700bar)</td>
<td>Large</td>
<td>+Y</td>
<td>No</td>
</tr>
</tbody>
</table>
Simulation Results

- Hydrogen Leak in Dispenser

Dynamic simulation result of hydrogen leak in the dispenser (0.1s, 0.8s)

Dynamic simulation result of dispenser leak in electrolysis hydrogen station (7.2s, 26.4s, 50.4s)
Hydrogen Explosion in Storage

Dynamic simulation result of storage explosion in reforming hydrogen station

(0.132s, 0.148s, 0.157s)
This program gives much helpful information for trainee to understand effectively about the hydrogen fueling station, to operate more safely, and to make plans against emergency.

The final developed program may offer all the information about hydrogen fueling stations and may be not only the effective operator training program but also the public relations for safer use of hydrogen.

Safety Operation of Hydrogen Station

- Economical Support
- Continuous Research
- Assessment
- Experiment
- Scenario
- Simulation
- Education
- PR
- Code

Successful Development of Hydrogen Fueling Station

Promotion
Please Contact Us with Any Suggestion or Question!

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