

**Program of Study** : Doctoral program  
**Title of thesis** : Inherent occupational health assessment in chemical process development and design  
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## ABSTRACT

Sustainability is now a necessity to process industry. Therefore the safety, health, and environmental (SHE) evaluations are required in process design and operation. Various methods for assessing safety and environmental friendliness have been presented in literature. However, occupational health evaluations have received much less attention even though each year more people die from work-related diseases than are killed in industrial accidents.

Inherent occupational health assessment is an approach to reduce hazards by choosing healthier chemicals and process concepts. I.e. inherent occupational health relies on the healthier and safer properties of chemical substances, process conditions, operations, and work procedures in a process. This thesis presents new systematic approaches for evaluating inherent occupational health of chemical processes in process development and design.

In the R&D stage, the Inherent Occupational Health Index (IOHI) is proposed based on healthier and safer reaction chemistries, properties of compounds present, and process conditions such as pressure, volatility, exposure limits, and temperature etc. In the preliminary design stage, chronic health risk is calculated due to exposure to fugitive airborne emissions based on flow sheet data and precalculated process modules' emission, estimated process plot areas, and wind velocities. Health Quotient Index (HQI) is used as a health indicator to compare the estimated chemical concentrations to their exposure limits.

In the basic engineering stage, the Occupational Health Index (OHI) utilizes detailed fugitive emission calculations based on piping and instrumentation diagrams. The method evaluates quantitatively chronic inhalation risks to noncarcinogens and carcinogens, acute inhalation risk, and qualitatively dermal/eye risk.

For fugitive exposure estimation new methods were developed. Three approaches for estimating chemical concentration due to fugitive emissions are proposed based on simple PFD, detailed PFD, and PID, which were tested on the actual Borealis Polymers plant in Porvoo. A more realistic approach was developed for estimating health risks of fugitive occupational exposure by using statistical meteorological data.

Finally the integration of the inherent occupational assessment methods with the existing computer aided design tools was studied. Also the correlation between index-based SHE assessment techniques was analyzed to find out, if any interdependency exists between SHE characteristics at the inherent level.

**Keywords:** inherent occupational health, process development, process design, inhalative exposure, fugitive emission, health risk, index method.