통합위험관리시스템(IRMS)을 위한 피해예측시스템의 개발

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Development of Consequence Analysis System for Integrated Risk Management System

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INTRODUCTION

In the chemical process industries, consequence analysis and risk management is very important because of their potential risk of hazardous materials. Therefore, we have developed many methodologies and applications for hazard evaluation.

According to ILO report, around 2.5 million cases of accidents involving about 335,000 deaths occur each year throughout the world despite the efforts through industrial accident prevention programs and improvements of work environments. Especially, the chemical industry uses a high concentration of sophisticated technical devices for handling, storage, shipping, and processing of many types of chemicals. These equipments have inherent dangers such as fire, explosion, leakage, etc. due to the nature of chemicals themselves. If such accidents happen, they affect severely not only the workers engaged in the chemical industry but also the residents and the environment of surrounding area.

So, the Korean government has been enforcing an Industrial Safety Management Act in accordance with the Industrial Safety and Hygiene Act since the January of 1996 in an attempt to prevent major industrial accidents. Given this, the Korea Occupational Safety and Health Agency (KOSHA) which is under the Ministry of Labor is constructing an Integrated Risk Management System that is coordinated through a telecommunication network.

IRMS

IRMS is composed of various elements and they are inter-integrated by software. In term of risk management, firstly using hazard identification method such as HAZOP and Checklist, we shall find potential hazard. In this step, Database that includes the information of hazardous equipments such as capacity of equipment, hazardous material being handled, temperature, pressure, flammability, etc will be established. And it also includes previous accident information such as cause, effect and probability. Secondly, we find the frequency that the potential hazard can occur actual accidents. For this we will use ETA, FTA. And, we have to find the consequence of accidents. For this we will use consequence models in KOSHA's hand. These models form CARM that is software package.

Thirdly, we have to calculate the risk of which functions are frequency and consequence ($R = F \times C$), and decide whether it is acceptable or not in comparison with acceptable risk criteria. And we can see the risk contour using GIS technology. We can make emergency plan using it.

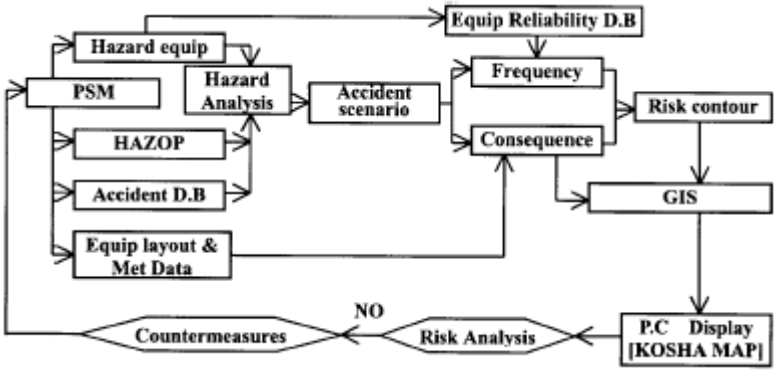

Figure 1: The Integrated Risk Management System (IRMS)

CARM

CARM is composed of material database, discharge calculation, dispersion calculation, heat effect calculation, over pressure effect calculation and wind field calculation modules. Material database modules has properties database of over 1000 materials. It can add properties of unique materials, and edit some properties when user wants to do. If user wants properties of mixture, CARM estimates them using general mixing rule such as Margules equation, van Laar equation, Wilson equation, and etc.

Discharge calculation module calculates discharge rate and exit state such as pressure, temperature, liquid fraction, and etc. It considers 12 cases of discharge scenario, whether equipment has accumulation or not, whether it suffer from rupture or leakage, whether phase of outflow is liquid, gas or aerosol. Each 12 cases calculate the result using their own fluid dynamic model. If the outflow is liquid phase, we calculate pool radius, dividing confined pool and unconfined one. Then we get pool radius, considering weather condition and ground condition, we have to calculate evaporating rate, which is added to gas phase outflow rate.

Dispersion module consists of light gas model and dense gas model. The criterion of classification gas is Richardson number. Because the dispersion of light gas has relatively weak damage, we choose some rough model Gaussian model. But dispersion of dense gas occur serious damage, so we improve model, which is based on SLAB. In our dense gas model, the distribution of plume is calculated by mean of the superposition of puff. As the result, we remove assumptions of fixed rate of release and no change of wind direction. Each model has plume model and puff model. Plume model handle continuous release and puff model handle instantaneous release. They make distributions of

concentration and show the contour of concentration on screen.

Heat effect model consist of three models, fireball, jet fire and pool fire. Each model can get the footprint of heat flux and graph of heat flux by distance. They convert the mass of fuel to TNT equivalent and calculate view factor at receptor's position. Finally, they get heat flux by means of multiply view factor, the rate of source radiation and screening parameter. Overpressure effect model consist of VCE (vapor cloud expanding vapor explosion), BLEVE (boiling liquid explosion), and pressurized vessel explosion. Also Overpressure model can do it with what heat effect model does.

Wind field module calculates weather condition at accident position by means of synthesis information from weathercocks. It also can edit weather parameters such as ambient temperature, relative humidity and etc.

Each model connected with a scenario database, which includes accident scenarios, discharge information and weather parameters. And its outputs gather on risk analysis module, Risk analysis module calculates probit values, which can change a risk. If we execute ETA or FTA together, CARM can calculate the risk of selected scenario.

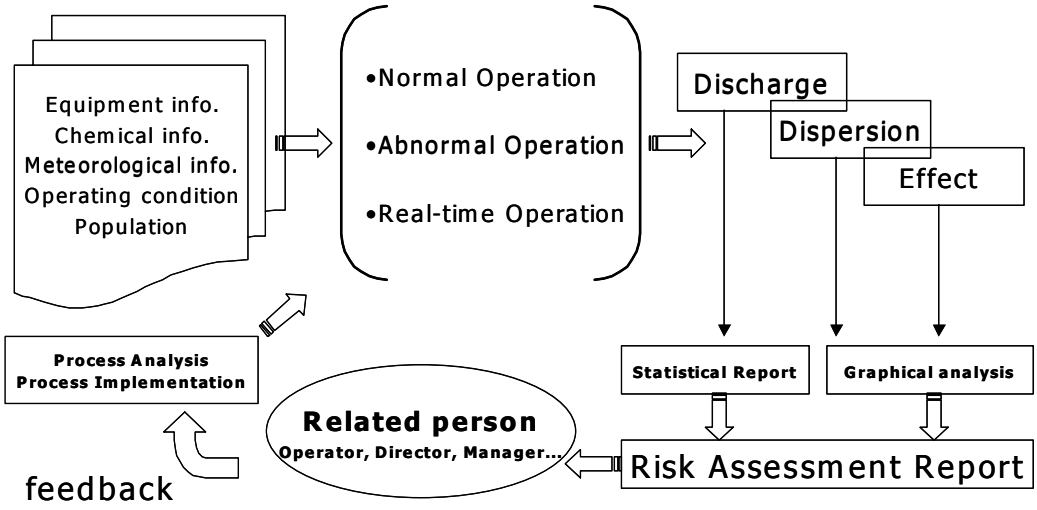

Figure 2: The calculation flow-chart of consequence analysis model

CONCLUSION

CARM is an element of IRMS of KOSHA, so when it is combined with other elements of IRMS, more powerful performance. The hazard analysis module of IRMS propose reliable scenarios, then consequence analysis module obtain the size of consequence, and frequency analysis module get the probability of selected scenario, these results is delivered to GIS display module and show risk contour and suggest emergency plan.

KOSHA has long term plan for IRMS such as dangerous installation database, installation reliability database, major past accident database, accident scenario database, and etc. If the IRMS being

constructed, it is used as the risk management for petroleum chemical industrial complex in Korea, a substantial amount of benefit can be expected in many areas. Consequence analysis model has some point of advancing, so we make steady progress in technical aspect.

ACKNOWLEDGEMENT

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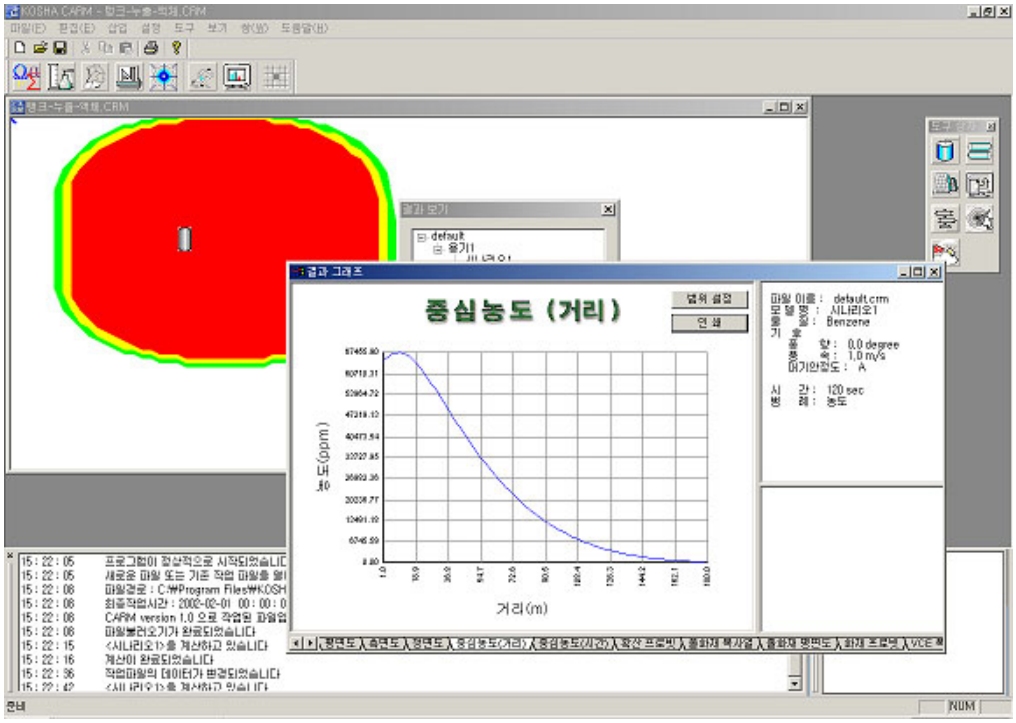

Figure 3: The software of consequence analysis model

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