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OF

THE CHINA ASSOCIATION FOR SCIENCE AND TECHNOLOGY

VOL. 6

Edited by

FENG Changgen SUN Xiaoli LI Shengcai

SHEN Aimin SU Qing

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VOL. 6

Part A: Selected papers presented at the 11th Annual Conference of the China Association for Science and Technology (September 7–10, 2009, Chongqing, China)

Part B: Selected papers published in Chinese journals sponsored by the member societies of the China Association for Science and Technology

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Introduction of the Content

This monograph (the Proceedings of the China Association for Science and Technology, Vol.6) collects 24 selected papers presented at the 11th Annual Conference of China Association for Science and Technology, Chongqing, September 7–10, 2009, and 57 selected papers published in Chinese journals sponsored by the member societies of the China Association for Science and Technology. These papers cover the following aspects: Agricultural Science, Chemistry and Chemical Engineering, Biology, Environmental Science and Technology, Medicine and Pharmacology, Safety Science and Technology, Mechanics, Forestry, Traffic Engineering, Physics, and Miscellaneous. Many novel research results on these fields achieved during the last few years are mentioned in the Proceedings.

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Preface

To enlarge the service and influence of the Chinese scientific papers to the researchers and other users of the English-language world and promote the international exchange between Chinese and foreign scientists, the English-language Proceedings (the Proceedings of the China Association for Science and Technology) has been inaugurated in series since 2004. Collected in this volume are 81 English papers selected from the 11th Annual Conference of the China Association for Science and Technology held in Chongqing, China, September 7–10, 2009, and the Chinese journals which are sponsored by the 170 member societies (their names are listed in the back of this Proceedings) of the China Association for Science and Technology.

The Annual Conference of the China Association for Science and Technology has entered its eleventh one since 1999. It is gratifying that the eleven annual conferences have won the high recognition of the Chinese government and the scholars from home and abroad. The Conferences provide a forum for the open exchange of information and ideas in the fields of science and technology.

The papers cover the following aspects: Agricultural Science, Chemistry and Chemical Engineering, Biology, Environmental Science and Technology, Medicine and Pharmacology, Safety Science and Technology, Mechanics, Forestry, Traffic Engineering, Physics, and Miscellaneous.

It is sincerely hoped that, as a consequence of this conference, the academic exchange between specialists and scholars would be continued and strengthened.

In addition, we greatly appreciate the authors for providing the excellent papers describing their latest achievements in their researches.

The Editors
December, 2009
Beijing, China

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Part A

Selected Papers Presented at the 11th Annual Conference of the China Association for Science and Technology

(Chongqing, China, September 7–10, 2009)

Study on Fire Temperature Field of Narrow Cabin

WANG Lei & PU Jinyun

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Abstract: In order to research fire properties in a narrow submarine cabin, a physical model and mathematical model was proposed to describe the fire development in the cabin. On the basis of the proposed models and by using field simulation and EBU combustion calculation software phoenics, the cabin temperature field distributions in different ventilation conditions was numerically simulated, the distribution laws and change trend of the temperature field of the cabin in different ventilation conditions were obtained. The oxygen concentration is pointed as the key factor affected the fire development in the narrow cabin, at last the fire effect in different ventilation conditions was discussed.

Keywords: fire fighting; ventilation; field simulation; temperature

1 Introduction

Since 1900s, the total number of great accidents in submarine has come to more than 170 times in the world peacetime. The main reasons of the submarine sunken are the fire (account for 38%), breakage(account for 19%), explosion and collision, etc(account for 37.5%). The submarine cabin spaces are more confined in submarine than the ships, the equipments relevancy is high and the work condition is unpleasant, hence the submarine fire spreads more quickly and the fire calamity become more severity. Since the later decade of the 20th century, some research on submarine fire safety had been done in foreign navy armies. An important idea has been brought forward that the study theory and results could not be directly used in submarine fire research. At present, the similar study still scarcity in china, while the related external research reports are hardly gained.

In this study, to accurately predict the fire behavior in the hermetic submarine cabin under different ventilation conditions, field simulation computing method and EBU combustion model are used, Software PHOENICS is selected as the numerical computing tool.

2 Fire physics Model and Basic Parameters

2.1 Geometry Sizes and Surface Material

The submarine cabin is assumed 1.73 m×1.47 m×2.53 m, the cabin wall is made of the steel which is 0.078 inch thick, the size of the vent-pipe is 0.30 m×0.30 m, the capacity of the ventilator is 3.54 m^3/min. Figs.1-2 illustrate the inner structural of the cabin and four thermocouples.

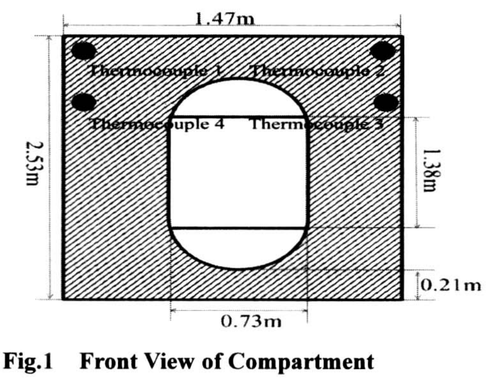

Fig.1 Front View of Compartment

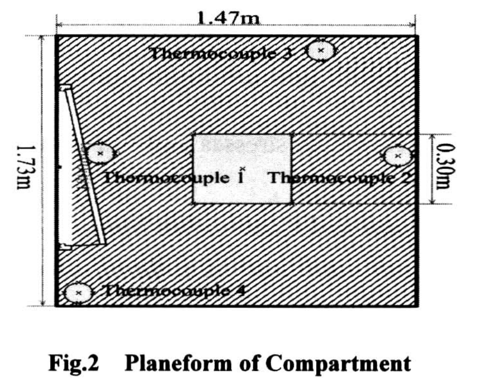

Fig.2 Planeform of Compartment

2.2 Fire Source Setting

The fire source in the cabin is a plastic trash bin, located at the center of the cabin floor. Its radius is about 25 cm, and about 61 cm high.

2.3 Initialization and Boundary Conditions

The smoke flow induced by the fire is supposed to be an unstable course after the ignition, to calculate the fire field parameters require to know the parameters in the fluid field at a certain moment (usually at the begin time). Assumed at t=0 s, the pressure is P_0, the velocity is approximately zero and the temperature is 22 ℃, the cabin wall boundary condition is seemed to be non-slippery.

2.4 Ventilation Conditions

Four different ventilation conditions setting of the submarine cabin is shown in the Table 1.

Table 1 Ventilation setting in different experiments

TEST	Nature ventilation	Forced ventilation
I	ON	ON
II	ON	OFF
III	OFF	ON
IV	OFF	OFF

3 Mathematical Model

3.1 Field Simulation Model

Field parameters are several estate parameters such as velocity, temperature and product concentration in space distribution. Field simulation model are a serials of mathematics equations, which can be calculated to obtain those parameters variety along with the fire development. The theory is based on the ubiquitous nature rules: the mass conservation rule (continuity equation), the viscosity liquid dynamics momentum conservation rule (Navier-stokes equation), conversation of energy rule and the chemistry feedback law[5-11]. The submarine cabin space is detached as limited control volumes, conversation rules construct the basic equations inner and connections of the control volumes.

Continuity equation:

$$\frac{\partial \rho}{\partial t}+\nabla\cdot(\rho U)=S$$

Navier-stokes equation:

$$\frac{\partial \rho U}{\partial t}+\nabla(\rho U\otimes U)+\nabla p=\rho g+f+\nabla\tau$$

Energy equation:

$$\frac{\partial \rho H}{\partial t}+\nabla(\rho U H)-\nabla(\lambda\nabla T)=\frac{\partial p}{\partial t}\qquad H=h+1/2U^2$$

Equation of state:

$$\rho=\rho(p,T)\qquad h=h(p,T)$$

where "t" denotes time, "ρ"is the fluid density, "U" denotes the control volume fluid velocity, "S" denotes the fountain source, which is mostly zero, but if there is the chemistry reactions or some reactant change their matter state, it denotes the new substance produce rate. "f" denotes the external power vector, "P" denotes pressure, "τ" is the Reynolds stresses and "H" denotes the total enthalpy, "h" is the enthalpy relative to the begin temperature.

3.2 *k*-ε Model and Combustion Model

The k-ε model is adopted as the turbulent model, two control equations are used to calculate the k and ε:

$$\rho\frac{\partial k}{\partial t}+\rho u_j\frac{\partial k}{\partial x_j}=\frac{\partial}{\partial x_j}[(\eta+\frac{\mu_t}{\sigma_k})\frac{\partial \kappa}{\partial x_j}]+\eta_t\frac{\partial u_i}{\partial x_j}\left(\frac{\partial u_j}{\partial x_i}+\frac{\partial u_i}{\partial x_j}\right)-\rho\varepsilon$$

$$\rho\frac{\partial \varepsilon}{\partial t}+\rho u_k\frac{\partial \varepsilon}{\partial x_k}=\frac{\partial}{\partial x_k}[(\mu+\frac{\eta_t}{\sigma_\varepsilon})\frac{\partial \varepsilon}{\partial x_k}]+\frac{C_1\varepsilon}{\kappa}\eta_t\frac{\partial u_i}{\partial x_j}\left(\frac{\partial u_i}{\partial x_j}+\frac{\partial u_j}{\partial x_i}\right)-C_2\rho\frac{\varepsilon^2}{\kappa}$$

where "μ_t" is the turbulent viscosity coefficient, C_1 and C_2 are constant, which is adopt as 1.44 and 1.92, the

Prandtl number σ_ε is 1.3, σ_k is 1.0.

The eddy break up model based on the eddy dissipation concept is used as the combustion model, the turbulent combustion rate expression equation is:

$$R_{fu} = -A\rho\frac{\varepsilon}{k}\min(m_{fu}, m_{ox}/s, \frac{m_{pr}}{B+BS})$$

3.3 Numerical Method

The finite-volume and structured grid method are used to disperse the governing equations, SIMPLEST computation method is adopted to solve the coupling problem of the pressure and the velocity. The spatial volume domain is detached as 62500 control volumes, the total simulation time is average divided to 135steps, each step costs 20 seconds and iterative 20 times.

4 Simulation Results and Analysis

Fig.3 shows the heat release rate change trend of the plastic ash bin.

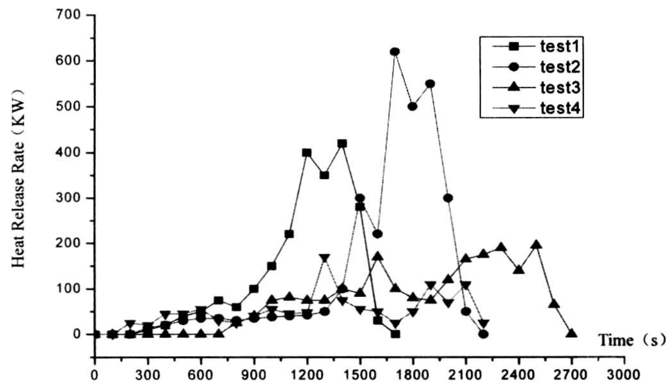

Fig.3 Fire heating release curve under variety ventilation conditions

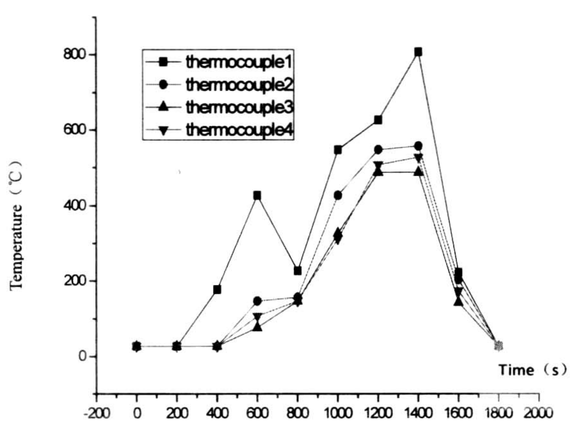

Fig.4 Door open, Ventilation open

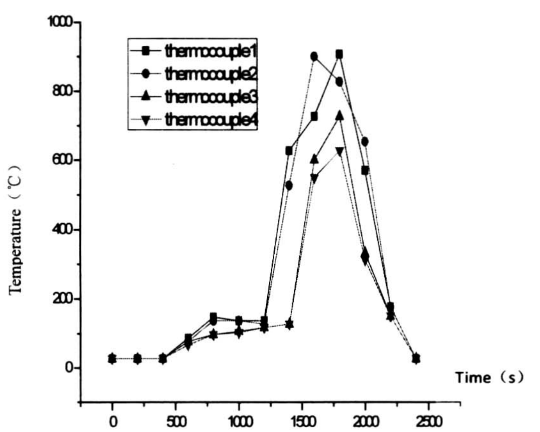

Fig.5 Door open ,Ventilation off

The simulated temperatures change trend of four thermocouples under different ventilation conditions are compared as shown in Figs.4–7. Both nature and mechanical ventilation can promote the fire development and increase the fire harm on the narrow space of submarine cabin. When the door is open and forced ventilation is on, the temperature increases more faster at the top upon the cabin door than other locations, the temperature of thermocouple 1 was higher than thermocouple 2. After 20 minutes, the fire fiercely developed and the peak temperature of thermocouple 1 reached about 600 ℃. When the door is open and the forced ventilation is off, 30 minutes was needed to reach the fire peak spread stage. An conclusion could be summarized that the supplement of oxygen may augment the combustion of fire sources, and rapid impelled the temperature. A phenomenon was observed that the temperature field presented symmetry in level direction and layered in upright direction, the phenomenon was distinct in airtight circumstance, while wasn't patency if the door was open and the forced ventilation was turned on.

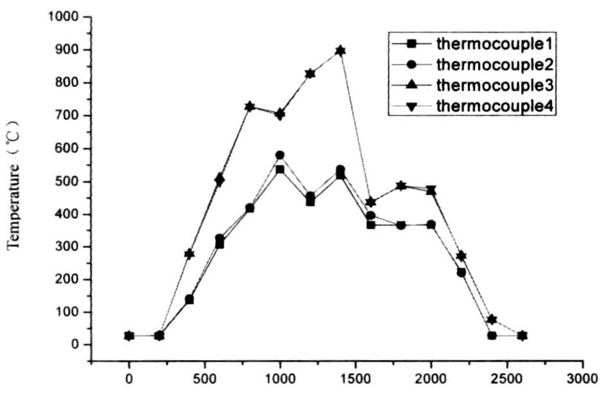

Fig.6 Door closed, Ventilation open

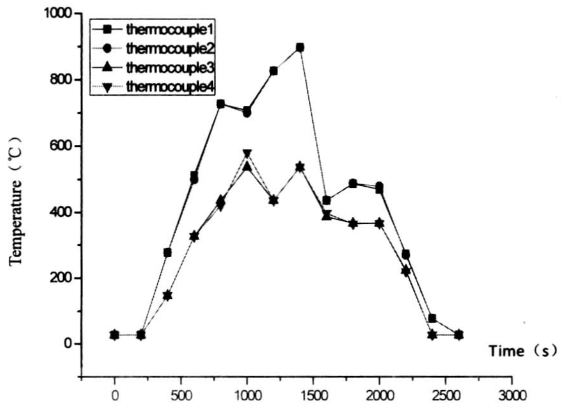

Fig.7 Door closed, Ventilation off

In condition of the nature ventilation and the mechanic ventilation work, the fire developed fastest and the fire duration was shorter-lived than under other ventilation conditions. The peak temperature of the thermocouple was highest in this situation. If the door and mechanic ventilation did not both turned on, the fire sustaining longer, which indicated that proper ventilation can prolong the cabin fire. The temperatures of thermocouples were fluctuating, fresh oxygen supplement were brought in the cabin due to ventilations, and the cabin temperature upstream was non-linear and fluctuant.

5 Conclusions

(1) Oxygen concentration is the key factor affecting the fire process in submarine cabins. Fire temperature field development shows wavy trend depending on the oxygen concentration. Sufficient oxygen shortens the fire durative time, but increases its fatalness. Appropriate oxygen concentration prolongs the fire durative time, which is the most dangerous. Hatch battening can reduces the fire durative time, meanwhile reducing the harm of fire.

(2) Under natural ventilation or forced ventilation conditions, cabin temperature field is symmetrical in horizontal plane, presenting different layers in the vertical directions obviously. Under natural ventilation and forced ventilation conditions, the temperature layers are not obvious.

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Heat Shock Protein 72 Associated with Alpha-fetoprotein in Human Hepatocellular Carcinomas*

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Abstract: Alpha-fetoprotein (AFP) in adult serum often signals pathological conditions, particularly the presence of hepatocellular carcinoma (HCC) and germ cell tumors containing yolk sac cell elements. Heat shock protein 72 (HSP72) as a molecular chaperone has been confirmed to overexpress in epithelial carcinoma cells. There may be a possible correlation between the expression of HSP72 and AFP during the growth and differentiation of hepatocellular carcinoma cells. The purpose of the study was to investigate the interaction between heat shock protein 72 (HSP72) and alpha-fetoprotein (AFP) in human hepatocellular carcinomas. Material/Methods: The expression and localization of HSP72 and AFP in human hepatocellular carcinomas were determined by immunohistochemistry and confocal laser microscopy. The interaction between HSP72 and AFP in hepatocellular carcinoma cells was analyzed by immunoprecipitation and Western immunoblots. Results: Hepatocellular carcinoma synchronously co-expressed higher level of HSP72 and AFP than in adjacent normal liver tissues. HSP72 were stained in cell nuclei and cytoplasm respectively, while AFP stained in cell plasma. Based on Western blotting methods, AFP was detected in the immunoprecipitate of anti-HSP72 monoclonal antibody (mAb), while HSP72 existed in the immunoprecipitate of anti-AFP mAb. Conclusions: HSP72 and AFP expression are higher in hepatocellular carcinoma tissues. HSP72 is associated with alpha-fetoprotein in human hepatocellular carcinoma cells. The interaction between HSP72 and AFP in human hepatocellular carcinoma cells can be a new route for studying the pathogenesis and immunotherapy of hepatocellular carcinoma.

Keywords: heat shock protein 72(HSP72); alpha-fetoprotein(AFP); immunohistochemistry; confocal; immunoprecipitation; hepatocellular carcinoma

1 Introduction

Alpha-fetoprotein(AFP) is a major serum protein synthesized by fetal liver cells, yolk sac cells, and detected in trace amounts by the fetal gastrointestinal tract[1]. AFP appears to function as an osmotic and carrier protein in the fetus and to regulate the immune system by immunosuppressive functions, such as preventing immunological attacks to the embryo by the maternal immune system[1]. Reappearance of AFP in adult serum often signals pathological conditions, particularly the presence of hepatocellular carcinoma (HCC) and germ cell tumors containing yolk sac cell elements [2]. Now AFP has been successfully used as a diagnostic and prognostic tool for HCC. Although many investigations for the function of AFP had been carried out, the biological role of AFP is still a riddle so far.

Heat shock protein 72 (HSP72) belongs to the heat shock protein 70 family which are molecular chaperones emerging as biochemical regulators of cell growth, apoptosis, protein homeostasis and cellular targets of peptides[3-5]. Up-regulated expression of HSP72 during the growth of cancer cells has a close relationship with the epithelial carcinoma proliferation[6-8]. Several studies have showed that AFP plays some roles during cell survival and cell proliferation of hepatocellular carcinoma cells[9-11]. So there may be a possible correlation between the expression of HSP72 and AFP during the growth and differentiation of hepatocellular carcinoma cells. In this study, by immunohistochemistry, confocal laser microscopy and immunoprecipitation, Western immunoblots, we observed that HSP72 was associated with AFP in hepatocellular carcinoma cell cytoplasm. The interaction

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between HSP72 and AFP in human hepatocellular carcinoma cells will provide a new route for studying the pathogenesis and immunotherapy of hepatocellular carcinoma.

2 Materials and Methods

2.1 Reagents

Rabbit anti-human HSP72 antibody, mouse anti-human AFP monoclonal antibody, mouse anti-human β-actin monoclonal antibody, TRITC labeled goat anti-rabbit antibody and FITC labeled goat anti-mouse antibody were purchased from Santa Crus Company. EnVisionTM kits were purchased from Dako Biological Techology Company. ProteinA/G-agarose beads were purchased from Gene Company.

2.2 Specimens

Surgical specimens of 40 patients with primary hepatocellular cancer undergoing liver resection were obtained from the Affiliated Hospital, Shaanxi University of Chinese Medicine, Xianyang, China from 2001 to 2005. The patients consist of 23 males and 17 females, with a average age of 51.5 years, arranging from 37 to 65 years. Routine pathological diagnosis showed that all cases were primary hepatocellular carcinoma. Among them, 16 cases were well-differential type and 24 cases were poor differential. The specimens were fixed in 10% buffered formalin and embedded in paraffin. Serial sections, 5-μm-thick were cut and placed on MAS-coated glass slides.

2.3 Staining Methods

All sections were deparaffinnized and dehydrated with graded alcohol. Endogenous peroxidase was then blocked with 0.3% H_2O_2 diluted in methanol for 30 min at room temperature. Antigen retrieval was performed by treating the slides in citrate buffer in a microwave for 10 min. The slides were incubated in a moist chamber with HSP72 rabbit antibody (1:100) or AFP mouse monoclonal antibody (1:100) at 4 °C overnight respectively. After a complete wash in PBS, the slides were treated with HRP labeled goat anti-rabbit and goat anti-mouse antibody (1:100) for 45 min at 37 °C. After a complete wash in PBS, the slides were developed in 0.05% freshly prepared diaminobenzedine solution (DAB, Sigma Co.) for 8 min, and then counterstained with hematoxylin, dehydrated, air dried, and mounted. CEA was used to substitute for the primary antibody as a negative control. All sections were studied by light microscopy, at ×400 magnification, with a 1cm × 1cm ocular micrometer (a square defined a field). Under the microscope, one field was 250 × 250 μm^2. The immunoreactive fields in the hepatocellular carcinoma were studied by continuous cell counting in the restricted field.

2.4 Immunoflurescence and Confocal Laser Microscopy

All sections were deparaffinnized and dehydrated with graded alcohol. The tissues were blocked in 10 mL/L bovine serum albumin (BSA) for 30 min at room temperature, and then incubated with HSP72 rabbit antibody (1:100) or AFP mouse monoclonal antibody (1:100) at 4 °C overnight respectively. After a complete wash in PBS, the cells were treated with TRITC labeled goat anti-rabbit antibody or FITC labeled goat anti-mouse antibody (1:20) for 40 min at room temperature. After extensively washed, the stained cells were observed under a laser scanner confocal microscope Bio-Rad MRC 1024ES equipped with a Nikon (Tokyo, Japan) Diaphot inverted microscope. Anti-CEA was used to substitute for the primary antibody as a negative control.

2.5 Immunoprecipitation and Western Blot

The hepatocellular carcinoma tissues and normal liver tissues were separated through 100-well copper mesh. Then cells were treated with 0.5 g/L trypsin and 0.2 g/L EDTA. After washing with cold PBS, cells were centrifuged and harvested. Cells were then lysed with 500 μl of lysis buffer (10 mmol/L Tris-HCL, pH 7.4, 150 mmol/L NaCl, 1mL/L Triton X-100, 10 g/L Na-deoxycholate) containing 1 μg/mL pepstatin and 1 mmol/L phenyl-methylsulfonyl fluoride (PMSF). Also, 5 units of apyrase (Sigma, Co.) were added to the lysate to deplete endogenous ATP. The cell lysates were sonicated and clarified by centrifugation. The supernatants were preabsorbed with 20 μL protein A/G-agarose beads at 4 °C for 4 h. After centrifuged, the supernatants were incubated with 100 μL HSP72 rabbit antibody(1:100) or 100 μL AFP mouse monoclonal antibody(1:100) at 4 °C for 60 min. Then 50 μL protein A/G-agarose beads were added and incubated for 60 min at 4 °C. The