

Activity Report of EASTS IRG (International Research Group)

IRG-08-2005

Date of Submission: 23/8/2007

1. Name of IRG:

Research on the control mechanism and simulation of safety conditions of perishable foods transportation and logistics

2. List of research members:

- 1) Xie Ruhe (Representative)
Professor, Ph.D., Research Center for Logistics and Transportation, Guangzhou University, P.R.China
- 2) Cheng-Min Feng
Institute of Traffic and Transportation, National Chiao Tung University, Taiwan
- 3) Alan Foster
Research Fellow, Food Refrigeration and Process Engineering Research Centre (FRPERC), University of Bristol, UK.
- 4) Liu Guanghai
Research Center for Logistics and Transportation, Guangzhou University, P.R.China
- 5) Huang Chengzhou
Research Center for Logistics and Transportation, Guangzhou University, P.R.China

3. Purpose and Mission of IRG:

The present goal is to study Food Logistics Technical Conditions.

Cold-chain is a system engineering to ensure the quality and reduce the loss of foods during production, storage, transportation, distribution and retailing of perishable goods under certain low temperature environment. It is a part of cool logistics and transport technology. Because of the complicated environment and long transport duration, the refrigerated transportation is the key to keep the quality in the whole cold chain.

The world population is growing. It has increased from 5.3 billion in 1990 to 6.4 billion in 2000. It is predicted to be 11.2 billion by the year of 2010. In order to meet the food demands, an efficient refrigerated transportation is necessary. According to the statistics, there are at least 1 million refrigerated trucks and 400,000 refrigerated containers in use in the world. The retail value of the products transported can be estimated more than 1200 billion US dollars.

In China, fresh and live produces and other perishable goods need refrigerated transportation urgently. According to interrelated statistics, there are more than 7000 refrigerated railway cars, 30,000

refrigerated trucks, 100,000 tonnes water refrigerated vessels and 10000 refrigerated containers in use. However, the number is still deficient. Today, more than 120 million tonnes perishable goods need refrigerated transportation, but only half of them have been transported because of the restrict of condition and ability of refrigerated transport. More than 15% of foodstuff transported has decayed in the course of transport.

Low temperature is the key to keep the quality of perishable goods, but it is not the only necessary and sufficient condition. The excellent transport quality of perishable goods depends on the suitable control of temperature and humidity and the integrated use of multi-exercise. For example, Excessive low temperature would cause food frostbite and nutrition loss, on the other hand, excessive high temperature would result in rot. Excessive low humidity would cause serious weight-loss of food. On the other hand, excessive high humidity would result in mouldy. Moreover, temperature and humidity are only two main factors affecting quality of food transport.

This research aims to find the best control technology and method, which would keep the quality and reduce the weight-loss of perishable goods, and guarantee the edible safety of food, based on the character of perishable goods transportation.

In order to achieve the object, we will conduct a study to simulate the factors and find the principle of food. In the first, by means of refrigerated transportation experiment platform, we will test the best reference point under actual transport conditions by adjusting and controlling temperature, humidity, airflow and air composition, etc. In the second, we will set up heat and mass transfer models by computed simulation based on experiment data. The optimal control method would provide guidance for refrigerated transportation of perishable goods.

4. Past Achievements

4.1 Paper, Report or Book: (Title, Authors, Year, Name of journal etc.)

Degree thesis:

- 1) Zhang, Xiaoling. The status of refrigerated logistics and countermeasure analyzed of railway refrigerated logistics [Master thesis]. Tutor: Xie Ruhe. Changsha: Central South University. 2006.5
- 2) Guo, Zhengxiang. The development orientation of railway refrigerated unit and cost calculated method of refrigerated transportation [Master thesis]. Tutor: Xie Ruhe, Li Xiaomiao. Changsha: Central South University. 2005.11
- 3) Zong, Yan. Refrigerated logistics and the experiment on temperature distribution of refrigerated container [Master thesis]. Tutor: Xie Ruhe. Changsha: Central South University. 2005.11

Paper:

- 1) Xie Ruhe, Liu Guanghai. Heat balance model for refrigerated car and simulation and experimentation on the temperature field The 22th International Congress of Refrigeration. 2007.8, Beijing, China
- 2) Xie Ruhe, Liu Guanghai. Design and test on the simulating test-bed of refrigerated transportation condition. The 22th International Congress of Refrigeration. 2007.8, Beijing, China
- 3) Liu Guanghai, Xie Ruhe, Qu Ruigui. Study on outdoor high temperature parameter by Pearson-distribution model. The Journal of Chongqing Architecture University. 2007.8
- 4) Liu Guanghai, Xie Ruhe. The study on response factor method in unsteady heat transfer

- of railway refrigerator car. *China Railway Science*. 2007, 28(1)
- 5) Foster AM, Ketteringham LP, Swain MJ, Kondjoyan A, Havet M, Rouaud O & Evans JA. Design and development of apparatus to provide repeatable surface temperature-time treatments on inoculated food samples. *Journal of Food Engineering, Special issue – BUGDEATH*, 76(1); 7-18. 2006.
 - 6) Foster AM, Ketteringham LP, Purnell GL, Kondjoyan A, Havet M, & Evans JA. New apparatus to provide repeatable surface temperature-time treatments on inoculated food samples. *Journal of Food Engineering, Special issue – BUGDEATH*, 76(1);19-26. 2006.
 - 7) Foster, AM, Swain, MJ, Barrett, R, D'Agaro, P & James, SJ. Effectiveness and optimum jet velocity for a plane jet air curtain used to restrict cold room infiltration. *International Journal of Refrigeration*, 29(5);692-699. 2006.
 - 8) Foster, AM, Swain, MJ, Barrett, R, D'Agaro, P, Ketteringham, LP & James, SJ. Three-dimensional effects of an air curtain used to restrict cold room infiltration. *Applied Mathematical Modelling*, 31 (6);1109-1123. 2007.
 - 9) Foster, AM, Evans, JA & James SJ. Application of Computational Fluid Dynamics (CFD) modeling to retail display and storage of food (poster). 17th International Congress of Chemical and Process Engineering (CHISA), 7th September 2006.
 - 10) Purnell, G, Foster, AM, & James C. Development of an atmospheric steam surface pasteurisation unit. 17th International Congress of Chemical and Process Engineering (CHISA), 7th September 2006.
 - 11) Foster, AM, Madge M & Evans, JA. Optimising a multi-deck refrigerated display cabinet using CFD. IUFoST 13th World Congress of Food Science and Technology, 17-21 September 2006 Nantes, France.
 - 12) Foster, AM, Swain, MJ, Barrett, R, D'Agaro, P & Evans, JA. Predicted and measured infiltration through refrigerated cold store entrances (Poster). IUFoST 13th World Congress of Food Science and Technology, 17-21 September 2006 Nantes, France 351-352.
 - 13) Xie Ruhe, Liu Guanghai, Guo Chen. Design and test on the simulating test-bed of refrigerated transportation condition. *Journal of Refrigeration*, 2006, (6).
 - 14) Xie Ruhe, Liu Guanghai. Study on the transported condition of perishable goods. The National Conference of refrigerated transportation, 2006.10, Chengdu, China
 - 15) Xie Ruhe, Liu Guanghai. Heat balance models for refrigerator car and simulation on the temperature field. The National Conference of refrigerated transportation, 2006.10, Chengdu, China
 - 16) Xie Ruhe, Liu Guanghai. IIR list of refrigeration research priorities. *Journal of Refrigeration*, 2006, (3).
 - 17) Luo Rongwu, Xie Ruhe. Experiment on green pepper transportation. *Journal of Refrigeration*, 2006, (2).
 - 18) Liu Guanghai, Xie Ruhe, Ding Lixing. Study on Integrated Temperature Field Used in Air-conditioned Trains. *China Railway Science*. 2006, 27(1).
 - 19) Xie Ruhe, Liu Guanghai. Design and study on test-bed of refrigerated transportation. The 18th National Conference of Refrigeration, 2005.11, Kuming, China

- 20) Xie Ruhe, Wang Quanle. The development of refrigerated transportation unit. The 18th National Conference of Refrigeration, 2005.11, Kuming, China
- 21) Xie Ruhe, Chen Baoxing. The study on management of food logistics safety. The 18th National Conference of Refrigeration, 2005.11, Kuming, China
- 22) Xie Ruhe, Chen Baoxing. The correspond management of cold chain of fresh, live primary products. The 4th National Conference of Logistics, 2005.11, Guangzhou, China

4.2 Seminar, Symposium or Special Session: (Title, Date, Venue & abstract)

- 1) The 22th International Congress of Refrigeration, 2007.8, Beijing, China
Study on the simulating test-bed of refrigerated transportation condition
- 2) The 17th International Congress of Chemical and Process Engineering (CHISA), 2006.9, Prague, CZECH Repub
- 3) The National Conference of Refrigerated Transportation, 2006.10, Chengdu, China
Study on the transported condition of perishable goods
- 4) IUFoST 13th World Congress of Food Science and Technology, 2006.9, Nantes, France.
- 5) The 18th National Conference of Refrigeration, 2005.11, Kuming, China
The development of refrigerated transportation unit in China
- 6) The 4th National Conference of Logistics, 2005.11, Guangzhou, China
The correspond management of cold chain of fresh, live primary products
- 7) The 7th National Conference of Refrigerated Engineering, 2005.11, Kuming, China
The air-infiltration in the refrigerated transportation

4.3 Group meeting: (Date, Venue & abstract)

- 1) 2006.7, Guangzhou, China
Research members: Xie Ruhe, Liu Guanghai, Huang Chengzhou
Study on the development of refrigerated transportation unit all over the world
- 2) 2007.8, Guangzhou, China
Research members: Xie Ruhe, Alan Foster, Liu Guanghai, Huang Chengzhou
Study on the simulating test-bed of refrigerated transportation condition
- 3) 2007.8, Beijing, China
Research members: Xie Ruhe, Alan Foster, Liu Guanghai, Huang Chengzhou
Study on the refrigerated transportation of perishable goods all over the world

4.4 Result of Application to other research funds: (Name & result)

- 1) the National Natural Science Foundation of China (NSFC) (No. 50378091)
The transported condition of perishable goods and the simulating test-bed of refrigerated transportation condition
- 2) the Ministry of Railway of China (No. 2005X012)
The energy consumption of refrigerated transportation and the simulating test-bed of refrigerated transportation condition
- 3) The paper “Heat balance models for refrigerator car and simulation on the temperature field” got the third grade excellent paper in China Refrigerated Academy in 2007.
- 4) The paper “The correspond management of cold chain of fresh, live primary products” got the third grade excellent paper in China Logistics Academy in 2005.

4.5 Promotional activities of your IRG: (Home page, Newsletter, Mailing list etc.)

Our work will be shown in www.gd56.org

The E-mail address: ruhe_xie@yahoo.com

Will you continue your IRG activity in next term (after September 2007) ? [YES]

→ If “YES”, please answer the following questions.

5. Future research plan including time frame with the following items:

- Planned seminar, symposium etc. (Date & Venue)

- 1) The EASTS conference, 2007.9, Dalian, China
- 2) The National Conference of Refrigerated Transportation, 2007.10, Shanghai, China
- 3) The 6th National Conference of Logistics, 2007.11, Nanjing, China
- 4) The 19th National Conference of Refrigeration, 2008.11, China

- Possibility of Special Session at the next EASTS conference in 2009

A series of papers and reports should be published in the EASTS conference in 2009

- Special considerations to young researchers

Refrigerated transportation is a domain involving multi-subject and adopting various techniques, including logistics, transportation engineering, economic and management, mechanism manufacture, the technology of refrigeration, the technology of food processing, etc. Our research is comprehensive. It takes the leader in this research field.

On the other hand, 2~3 doctors and 2~3 masters will be brought up by the project.

6. Application for ICRA Grant

Will you apply for ICRA Grant ? [YES]

→ If “YES”, please choose one ICRA category among the two categories (A).

A. ICRA for incubating research,

which aims to support academic research works or to assist research meetings.

B. ICRA for publicity of achievement,

which aims to support publications, symposiums or seminars for the publicity of your IRG achievements.

Evaluation criteria of ICRA is based on “Internationality”, “Academic/Practical Novelty”, “Usefulness” and “Prospect” written in this activity report. Please reconfirm the features of this report.

If you choose “**A. ICRA for incubating research**”, please answer **6.A**, if “**B. ICRA for publicity of achievement**”, answer **6.B**.

6.A Budget for “A. ICRA for incubating research”

(Please note that the fund is for two years)

a) Personnel – only for the part-time workers, not for researchers
1000 US\$.

The subsidy of student (test / investigation / analysis)

b) Equipment

2000 US\$.

The inspecting system in the experiment

c) Supplies – Consumables, such as CD-R disks, etc

3000 US\$.

The raw and processed material of experiment / materia medica / reagent

The energy consumption in the experiment

d) Travel for conduct of research, symposium seminar etc.

1000 US\$.

Travel for conduct of research, symposium seminar etc

Publish the papers and reports

e) Other items of expense (itemized)

1000 US\$.

Information search / copy

Investigation

Relative software

Total 8000 US\$.

* Total amount requested – not to exceed 1,000,000 YEN (approximately 8,400 US\$)

* Budget can not include researchers' salary.

6.B Budget for “B. ICRA for publicity of achievement”

(Please note that the fund is for one year)

a) Travel for conduct of research, symposium seminar etc.

b) Supplies – Consumables, such as CD-R disks, etc.

e) Other items of expense (itemized)

* Total amount requested – not to exceed 500,000 YEN (approximately 4,200 US\$)

* Budget can not include researchers' salary.