Application Form of EASTS IRG (International Research Group)

IRG-08-2005

Date of Submission: 10/31/2005

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

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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 waste of foods during production, storage, transportation, distribution and retailing of perishable goods under certain low temperature environment. It is a part of cool logistics 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 in1990 to 6.4 billion in 2000. It is predicted to be 11.2 billion by the year of 2100. To meet the food demands of human, an efficient refrigerated transportation plays a key role. According to 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 railway-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 want to find the best control technology and method, which would keep the quality and reduce 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. Future research plan including time frame:

Research plan

Researchers have done a great deal of works about correlated problems. All of these provide a good basis for this study.

Researchers have been doing tests since 1970s. James and Cutting(1973,1984,1992) analyzed the weight-loss of meat during the course of cooling and storage. Investigation shows that the average weight loss of meat is 0.1% to 0.4% per day in cold storage rooms, 1% to 3% during the course of cooling, 0.2% to 0.4% during transportation. In China, According to the research of R.H. Xie (1999), the average weight loss of perishable goods is 0.3% per day in railways refrigerated transportation. This means more than 100 million Yuan per year is in loss.

Food safety is a crucial problem in nowadays. Many international institutions, for instance, the food refrigeration & process engineering research center of Bristol University in Britain, have been doing a lot of tests to track the growth of bacteria in low temperature condition. They also made enormous contributions in temperature legislation of cold chain.

Researchers also focus on the temperature distribution and air flow of transport units. At the beginning, studies have been done by experimental forms. Londahl(1977) discusses how to keep mass of refrigerated foods in transportation. The national railway institution of Italy(1980) simulated refrigerated transport conditions by sensors and food models. With the development of computer, studies have been done from experimental forms to simulated calculation. The results could be gained by solving sets of differential equations of mass, momentum and energy codes. It reduces the need for expensive and time-consuming experiments. Such studies have been done by many researchers, such as Van Gerwen and Van Oort(1989), Wang and Touber(1990), Hoang et al.(2000), Ménia et al.(2002).,etc.

Research objective, method and scheme:

This study is to find the best control method to keep the edible safety and quality and reduce weight-loss of perishable goods, based on the character of perishable goods transportation. We will conduct the study by combining experiments and computer simulation calculations.

In the first, basing on the integrated simulation test-platform under refrigerated transport conditions, simulate the quantitative change and qualitative change of perishable goods in different temperature and humidity conditions during transport, the goods includes typical fruit, vegetable, meat, aquatic products, etc. Analyze the quality of foods by making biologic and chemic methods.

In the second, determine the heat and mass transfer models, air velocity and temperature distribution by computer simulation basing on the experiments data. Compare and contrast the data from experiments and simulations, educe the optimal control mechanism of refrigerated transport.

At last, put the research results into true refrigerated transportation, analyse the character of transport unit, quantitative change of perishable goods. Inspect the effect of the control mechanism to compare the results both from actual and simulating transport.

Projected time frame:

1/1/2006~31/5/2006: Complete the integrated simulation test-platform of refrigerated transport conditions which was built in 2005 in our institute, collect related references;

1/6/2006~31/8/2006: Debug the integrated simulated test-platform; design experiment scheme;

1/9/2006~31/10/2006: Experiments of typical perishable goods in different temperature and humidity conditions in transport unit;

1/11/2006~31/12/2006: Experiments of typical perishable goods in different airflow in transport unit;

1/1/2007~30/5/2007: Computer simulation, determine the heat and mass transfer models, air velocity and temperature distributions;

1/6/2007~30/8/2007: Put the research results into true refrigerated transportation to verify, compare and modify;

1/9/2007~31/12/2007: Prepare research report and papers.