

“Temperature and Air Change Rates in Freight Containers during Transport between Europe and Destinations in Asia and Australia”

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Abstract:

This presentation will give an overview of the air change rates, temperatures, and humidity in freight containers during transportation from Europe to Singapore and Australia. A freight container fully equipped with measuring instruments was used. The container was fitted with a 28 channel temperature measurement system, GPS data logger and a temperature /humidity data logger. It was loaded with two intermediate bulk containers (IBC) and also four plastic drums of water with a capacity of 220 liters each. The temperature was measured inside the container at three different levels and at the top and bottom of the water in the IBCs and drums.

1. Introduction

This investigation was part of a research project with the title: “Permeation in plastics packagings with the risk of creating explosive atmospheres in freight containers under normal conditions of transport” and financed by the German Government through the Federal Ministry of Transport, Building and Urban Affairs.

The challenges of increasing world population and consumer behavior can only be met by transporting goods and resources between countries. The seven seas have become the playground of globalization and global trade is booming, as is the turnover in container handling in harbors around the world. The 20-foot steel box, so-called freight container, is the key to globalization.

The average rate of increase in freight containers is about 10 % annually (Figure 1).

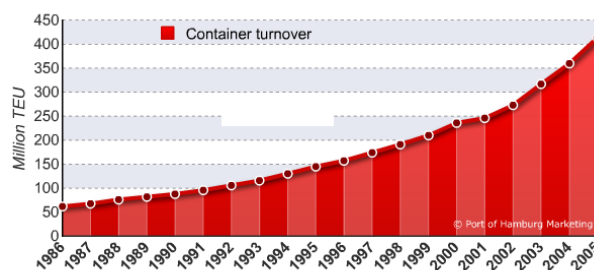


Figure 1: World container turnover

Source: Hafen Hamburg Marketing e.V.

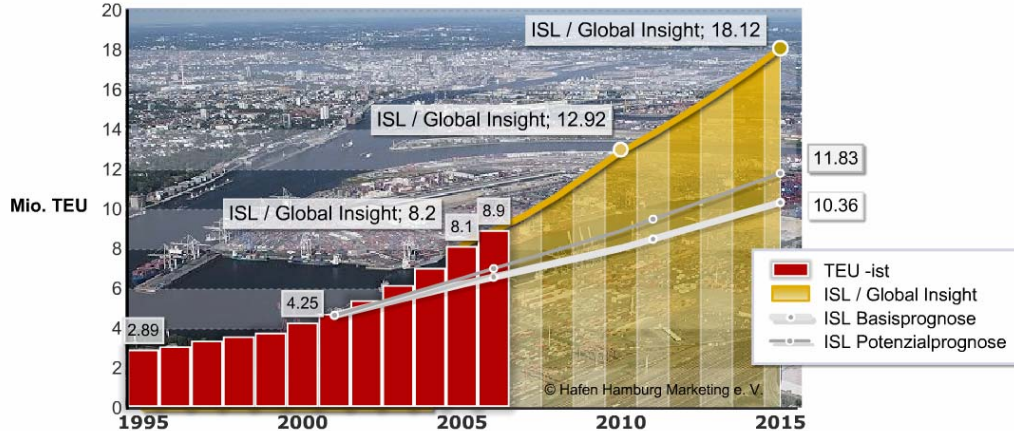


Figure 2: Prognosis of container handling in Hamburg Port

Source: Institut für Seeverkehrswirtschaft und Logistik in Bremen

The prognosis for the port of Hamburg in Germany (Figure 2) shows an annual growth in container handling of 10%. From 2005 to 2015 container handling will increase from about 9 to 18 million containers, a growth of more than 100 %.

One of the important things for cargo transportation in containers is sufficient knowledge of climatic conditions during transportation. Temperature, air exchange rate and humidity in the container are affected by external climate conditions, the cargo itself, and container type.

2. Measuring Air Change Rates

It would be good to have information about the necessary air change rate for containers under fumigation, containers with the risk of an explosive atmosphere building up, and containers with products needing fresh air during transport. As an example, large air changes in ventilated containers minimize the risk of an explosive atmosphere.

The tracer gas method with sulphur hexafluoride (SF_6) was used for a systematic investigation of air change rates in the container and truck. Basically, SF_6 was injected with a syringe into the container and mixed with a fan. Air samples were taken with an empty syringe in time intervals of 60 minutes, and the gas concentration in the syringe was analyzed by gas chromatography. The air change rate could be calculated from the change in the SF_6 concentration under the assumption that the SF_6 distribution was homogeneous. Figure 3 shows the results of the measurements. The lowest air change rate (0.02 air change rate per hour) was in a freight container with no vents in a storage room. In theory, therefore, the exchange of the total air in the container would take about 50 hours. The highest rates (0.2 air change rate per hour) were measured during a trip on the highway in a so called ventilated container with 32 passive vents.

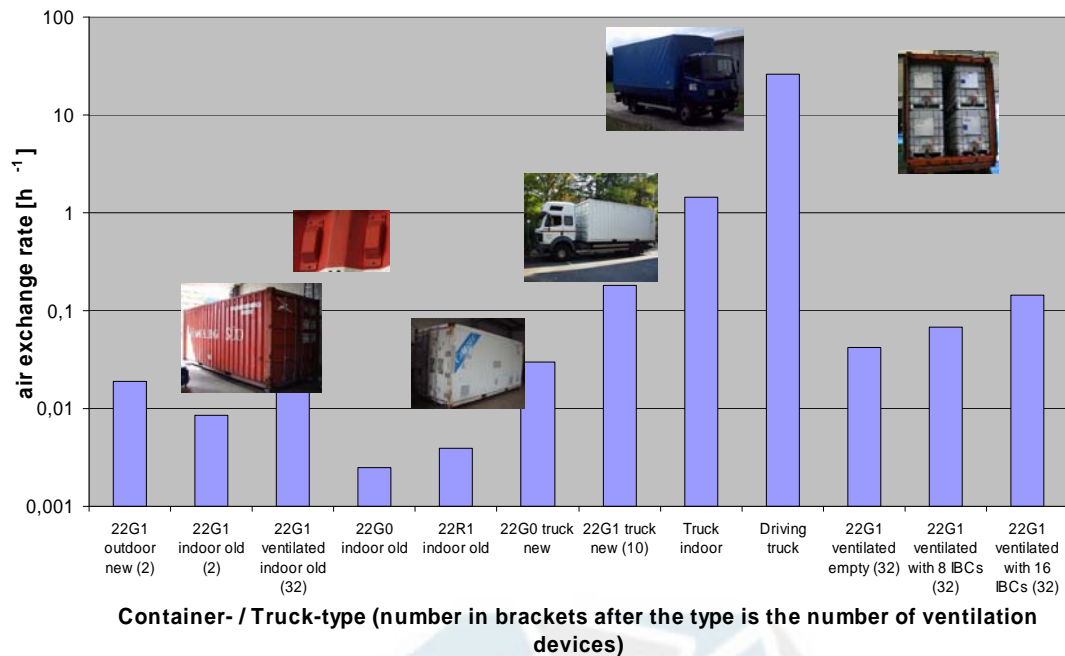


Figure 3: Overview of the air change rates for different containers and trucks

In general, it is very difficult to get a real-life ventilated container as they are very rare and used, for example, in the transportation of coffee beans. Such containers are loaded and unloaded in a closed loop. Therefore, we were unable to acquire one for the air change rate measurements.

3. Measuring Temperature

The goal of this investigation was to measure the temperature in typical plastic packagings and intermediate bulk container (IBC) for the transport of dangerous goods filled with water on common transportation routes from Europe to Asia.

One route was from Berlin in Germany to Singapore, storage time of three weeks in Singapore, and the transport back to Berlin. The second route was from Berlin to Melbourne, storage in Melbourne for four weeks and then back to Berlin.

A 20-foot freight container was loaded with two IBCs, each filled with 1000 liters of water, and four 220 liter plastic drums filled with water.

A 28-channel temperature data logger, GPS data logger and shock recorder were used for this study. The measurement container was able to collect data for six months without any battery charge. The GPS data logger was able to correlate data from the temperature-logger with the route and geographic position. The test setup of the instrumented container is shown in figure 4.

Temperature Measurements Measuring equipment, load and power supply

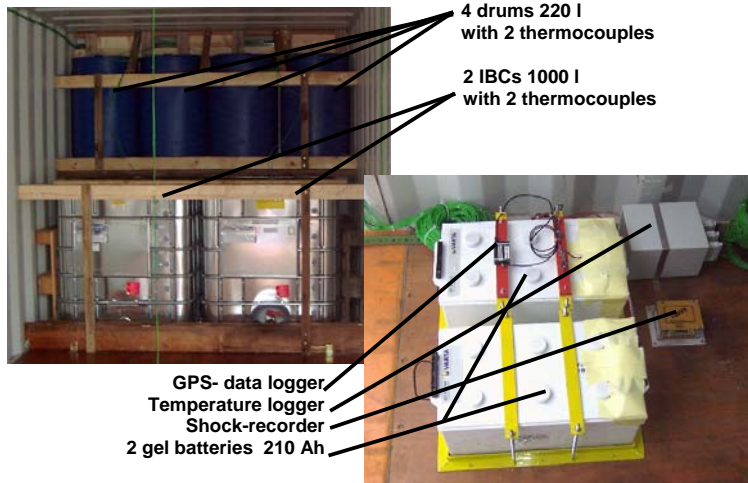


Figure 4: Test set-up in the container

Figure 5 shows, for example, the temperature during the transport from Berlin to Singapore and three weeks storage in the harbor. The maximum air temperature in the container was about 48°C, in the vapor space of the plastic drum 40°C and in the IBC 37°C. Due to the GPS data logger the exact route of the container and correlation between temperature and geographic position were possible. During transportation by a container ship to Singapore the container was under deck and no satellite signal received; on the way back the container was on deck and the GPS signal received.

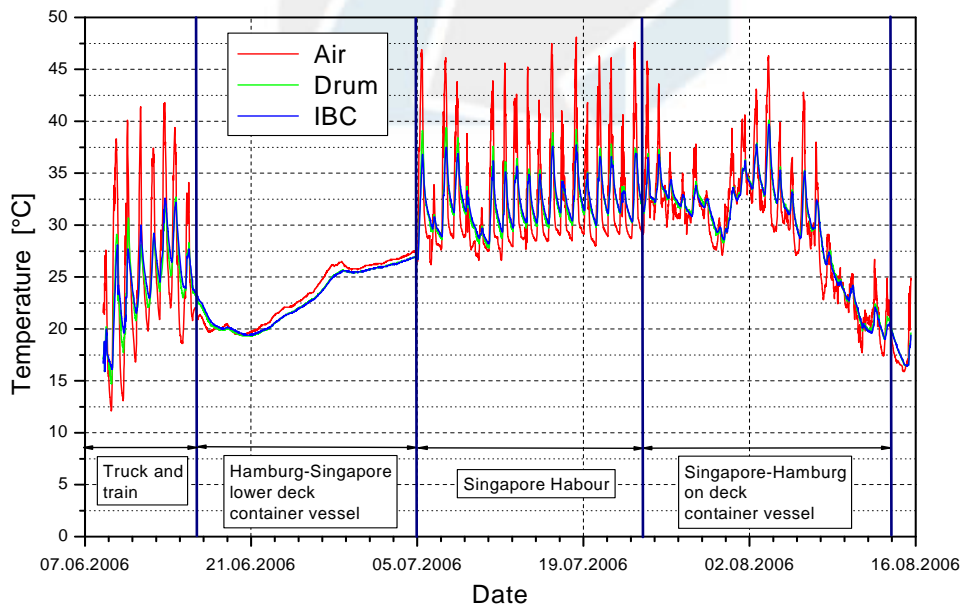


Figure 5: Temperatures in the container during transport and storage in Singapore

The highest temperatures were measured during storage in Singapore. The biggest influence on the temperature in the container was the sun. If the container was transported under deck, the daily temperature cycle could not be observed, and the temperature was much lower than on deck.

5. Conclusion

The goal of the investigation was to discover something about “normal conditions of transport” for the transport of dangerous goods world wide. It was not the intention to examine extreme conditions. The air change rate of 0.02 per hour measured in freight containers with no vents was very low.

Air temperatures of approximately 50°C in the container and 40°C in the packagings were identified as normal conditions of carriage.

Further studies with the focus on different routes and packagings may be useful.

