Scheduling Tank Container Movements for Chemical Logistics

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Logistics is the glue that binds the entities of a supply chain. More and more businesses have now realized that its effectiveness is critical to the superior performance of the supply chain. For instance, the move towards just in time and agile manufacturing has tremendously increased the impact of the logistics decisions. This is especially true for the chemical industry with its globally distributed plant sites, storage terminals, suppliers, customers, etc. The global transport of chemicals and a variety of other materials (e.g. plant equipment, instrumentation, indirect materials, safety equipment, etc.) is central to its day-to-day operations. Logistics costs can vary from 3.6% of the purchase price for a best-in-class (BIC) site to 20% at the other extreme (Karimi et al., 2002).

The transport of chemicals by pipelines is ideal. However, this is not always possible. Chemical logistics requires a mix of means such as trucks, trains, ships, barges, tankers, etc. Sea transport is the key to global chemical logistics. Bulk shipping of chemicals occurs in huge volumes, and involves very large crude carriers (VLCCs) and a variety of multi-parcel chemical tankers. The former routinely transport crude oils worldwide (Reddy et al., 2003), while the latter transport clean petrochemical products (CPP) and other chemicals such as vegetable oils (Jetlund & Karimi, 2003). However, there is another equally important segment of chemical logistics, called container shipping, which has received little attention in the literature. Moving and even storing low-volume and/or hazardous specialty chemicals and other food products by tank containers has become the most preferred option from the viewpoints of safety, cost, and environment. Furthermore, containerization facilitates for inter-modal transport over land and sea.

This paper addresses a key management issue faced by the chemical logistics companies in managing the positioning of empty tank containers. For many chemical companies and their third party logistics partners, minimizing the logistics costs arising from the container flow imbalances across the globe and container cleaning is are major issues. In contrast to dry containers, this important problem of managing tank containers in global chemical logistics has not received much attention. This paper presents an innovative, event-based, “pull” approach for the minimum-cost or the maximum-profit scheduling of the transport and cleaning of multi-product tank containers (loaded and empty) given a set of projected shipment orders. The problem turns out to be a continuous-time, linear programming formulation that successfully solves large, industrially relevant problems. Compared to the network modeling approach that has been used for traditional dry containers, our approach appears to be more efficient and flexible. Furthermore, our approach applies easily to dry containers also. Other key practical extensions such as alternate ship schedules, delivery time-windows, and inter-modal transport routes are also incorporated. The problem and the method

are illustrated through numerical examples. We have solved a problem one month of scheduling horizon involving 50 depots, 65 plant sites, 500 orders, and 8300 containers in less than a few seconds. This is very representative of a logistics company moving about 100,000 containers per year.