8 The Acid Chemical Co: Planning an Outline Schedule for a Fleet of Road Tankers

J. M. LAWSON

Central Investigation Department, Heavy Organic Chemicals Division, I.C.I. Ltd.

1 INTRODUCTION

The Transport Department of Acid Chemical Company operate a fleet of road tankers which are used for carrying two chemical intermediates. One of these is called Acidic and has to be delivered to customers in various parts of the country from Acid Chemical's own factory on Teesside. The other, which is called Caustic, is made by another company in Huddersfield and has to be transported to Acid Chemicals factory at Teesside where it is used in the manufacture of other chemicals. The traffic in both chemicals has expanded considerably over the years and the fleet has grown to match the demands made on it and now stands at a total of ten tankers, some of which have barrels split into two compartments. The fleet is based on Teesside where facilities exist for maintenance, servicing etc., and since a considerable amount of Acidic is used at Huddersfield by the same company that make Caustic, tankers calling there to deliver the Acidic usually make the return trip to Teesside carrying a load of Caustic.

However, the effectiveness of this two-way operation is severely limited because the same compartment of a barrel cannot be used for carrying both chemicals unless it is given a very thorough cleaning between journeys. This cleaning operation is not very expensive but it is hazardous to health, so that up to the present, the Transport Manager has not allowed it to take place. In the future,

the Transport Manager is only willing to undertake the cleaning if he can see that it will save him from purchasing another vehicle to transport the tonnages of Acidic and Caustic which are forecast for the coming year. Even then he is only prepared to have compartments cleaned out once at the beginning of the year.

The Transport Manager has already received the forecasts of Acidic and Caustic deliveries for the coming year, and has decided that, because he has found the forecasts for these two chemicals to be fairly reliable in previous years, they should form a reasonable basis for making his plans. He decides that he has a number of important questions to answer:

1. Is the existing tanker fleet capable of meeting the demands which will be made on it next year without modifications to the size or number of compartments in any barrel and without cleaning out any compartments?
2. If so, what advantage would there be in cleaning out compartments and how should the tankers be allocated to the various duties so that the chemicals are transported for the least total cost?
3. If not, what size of fleet is required? What changes should be made to the compartments and once again how should the tankers be allocated to the duties to be performed to minimize the total cost?

He realizes that these are not very simple questions, indeed he has had to wrestle with them many times before and has never been entirely satisfied that he has found the best answers. He therefore

Table 8.1 The tanker fleet available for transporting Acidic and Caustic next year

Type of tanker[a]	Number	Capacity for carrying Acidic (tons nett)	Capacity for carrying Caustic (tons nett)
Single compartment (Type A)	1	16·5	0
Single compartment (Type B)	3	0	16·5
Double compartment (Type C)	6	5·5	16·5
Double compartment (Type D)	0	16·5	5·5
Totals	10	49·5	148·5

seeks the aid of the Operational Research Department who send a man across to help. The O.R. scientist and the manager sit down together and between them they decide that for practical purposes the problem can be described in the following way.

2 STATEMENT OF THE PROBLEM

Table 8.1 displays the capacities of the tankers as they stand at the present time and also shows which chemical they are being used for until the beginning of next year. The compartmented barrels are not divided up into equal parts because small compartments of 5·5 tons capacity were designed to carry the exact quantity of Acidic which can be off-loaded at the depots at Huddersfield and Manchester C at any one time. Neither of these depots can handle a load of more than 5·5 tons of Acidic since storage facilities are limited because of the high capital costs. The other eight depots which receive Acidic use it for a different purpose and they can store much larger quantities because they do not have to maintain stringent conditions to prevent contamination. However, none of them will accept loads of less than 15 tons at a time. By law, no tanker is allowed to carry more than 16·5 tons of these types of chemicals

Table 8.2 The quantities of Acidic and Caustic to be transported next year

Product	From	To	Tonnage
Caustic	Huddersfield	Teesside	53,000
Acidic	Teesside	Huddersfield[a]	9000
Acidic	Teesside	Blackpool	6000
Acidic	Teesside	Manchester A	4000
Acidic	Teesside	Manchester B	2200
Acidic	Teesside	Manchester C[a]	950
Acidic	Teesside	Chester	6200
Acidic	Teesside	Cardiff	2000
Acidic	Teesside	London	900
Acidic	Teesside	Grimsby	650
Acidic	Teesside	Hull	350

[a] These depots can only take 5·5 tons of Acidic at any one time because of limited storage facilities.

at any one time because of the dangers which larger loads would present in the case of accidents.

Table 8.2 shows the quantities of Acidic and Caustic which have to be moved between the various depots involved and Figure 8.1 gives an indication of their relative positions. Tankers are available

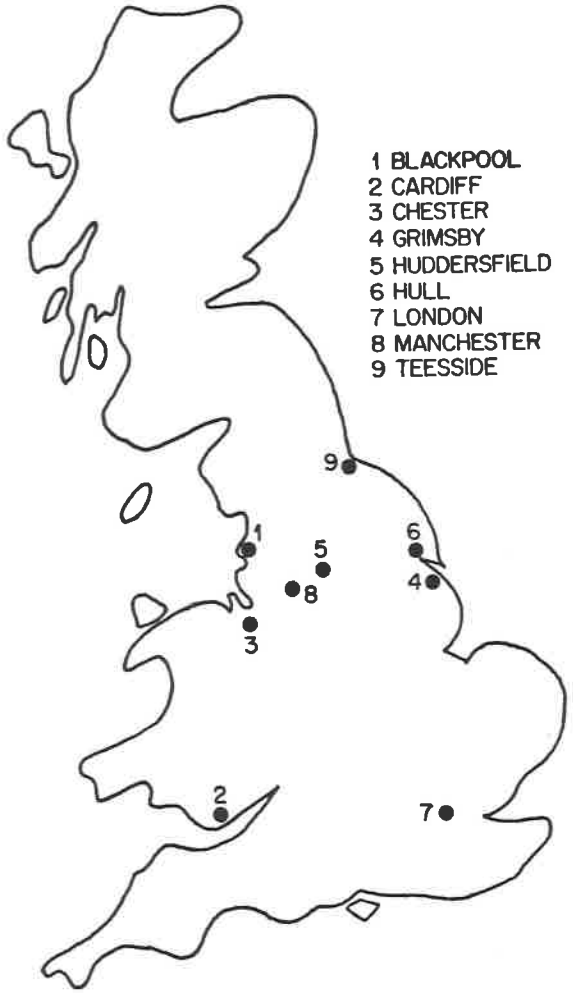

Figure 8.1

on average for 60 per cent of the year (5240 hours) the remaining 40 per cent being required for inspection and maintenance etc. It is not considered that availability can be improved upon to any significant extent because the majority of the time spent in the workshops is taken up with routine work which directly affects the safety of the vehicles.

Although there will be variations in demand from week to week, consumption and production of both chemicals proceeds at a fairly steady rate and experience has shown that the flexibility required to meet normal variations in demand can be gained by adjustment of maintenance schedules.

Although eleven different locations are involved clearly only a limited number of routes need to be considered in trying to decide which tanker should be assigned to which route and for what proportion of the time it is available. Close study of Figure 8.1. shows this fairly readily. For example, there is no need to consider using the route between London and Grimsby since a full load of Acidic can be delivered to either depot and a tanker would have no cause to visit both on one journey from Teesside. On the other hand it may be worthwhile getting certain tankers which have been to Acidic users in London, Cardiff, etc., to call in at Huddersfield to pick up some Caustic on their way back to Teesside, especially if it is found to be worthwhile converting some Type C tankers to carry 16·5 tons of Acidic and 5·5 of Caustic. There is no point in routing the three Type B tankers anywhere but between Huddersfield and Teesside, but it might be found necessary to convert one or more to Type A tankers. There would clearly be little point in converting a compartmented barrel into a single barrel and it is not possible to add to the single compartment barrels to give them two compartments. Table 8.3 shows the distances and times involved in the various round journeys which one might reasonably expect to consider in studying the questions posed.

The cost of operating the fleet may be split into two parts, the cost of providing a new tanker, taxed, insured, etc., and ready for the road is about £8000. The cost of preparing an existing tanker for use (i.e. tax, insurance, etc.,) is about £200. The resale value of tankers which would be disposed of if not needed is approximately £3000.

The cost of operating the tankers, once they have been prepared for the road, is proportional to the mileage covered at the rate of 10p per mile.

Table 8.3

Journey	Distance (miles)	Duration (hours)
Teesside–Huddersfield return	166	11·0
Teesside–Blackpool return	280	13·0
Teesside–Blackpool–Huddersfield–Teesside	298	15·0
Teesside–Manchester A return[a]	210	12·5
Teesside–Manchester B return[a]	224	12·0
Teesside–Manchester C return[a]	228	12·0
Teesside–Chester return[a]	330	23·0
Teesside–Cardiff return[a]	520	30·0
Teesside–London return	480	26·0
Teesside–London–Huddersfield–Teesside	503	30·0
Teesside–Grimsby return[b]	270	13·0
Teesside–Hull return[b]	190	11·0

[a] These routes pass sufficiently close to the Huddersfield depot that the detour necessary to load or unload there makes a negligible difference to the journey distance or duration.
[b] Journey times and distances between Hull and Grimsby and Huddersfield are such that round trips of the type Teesside–Hull or Grimsby–Huddersfield–Teesside are not considered worthwhile.