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An Economic Rating of the Pipeline as a Mode of Transport

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Abstract: The ancestry of the pipeline as a mode transport in its own right is traced to as early as 400 BC. It is most suitable for the transportation of gases and liquids, as well as any chemically stable substance. Technological advancement has extended the frontiers of its application to the transportation of slurry and solid cargo. In the study, the pipeline is subjected to a comparison with other modes, through the methodology of literature review and content analysis . It is found that the pipeline ranks ahead of road, rail, waterway and air in the long distance, strategic conveyance of fluid cargo. The major points of pipeline superiority include, among others, its climatic neutrality, geographical indifference, environmental friendliness and the declining long-run average cost curve associated with it.

Key words: Pipeline, cost advantage, environmental compatibility, fluid transportation

INTRODUCTION

The pipeline is a line of pipe equipped with pumps and valves and other control devices for moving liquids, gases and slurries (fine particles suspended in liquid). Pipeline sizes vary from the two-inch-diameter lines used in oil well gathering system to lines thirty feet across in high-volume water and sewage networks.

Because they are usually out of sight, mostly laid underground, their contribution to freight transport and importance to the economy are often unrecognized by the general public. Pipelines have been the preferred mode of transport for liquids and gas over competing modes such as truck and rail for several reasons. They are less damaging to the environment, less susceptible to theft and more economical, safe, convenient and reliable than other modes[1].

Gases and liquids, as well as any chemically stable substance are particularly suited for pipeline transportation, including beer, as in the study of bars in the Aufschaike Arena which are interconnected by a five kilometer long beer pipeline to ease distribution during matches[2].

Pipelines, especially when carrying petroleum products are governed by their own set of operational philosophy and procedures. The areas of consideration for safe and economic transportation of several different products through a pipeline include:-

- sequence of products, control of interfaces and quality control of all products
- cycle length and parcel sizes relative to terminal and refinery storage
- economic use of energy to meet changing demand
- accurate scheduling to prevent stock run out and oversupply
- accurate measurement and accounting
- accurate monitoring and production of parcel position to ensure adequate handling of products and ensure correct tankage at receiving terminals.
- Safe operation of the system design limits, including protection of people, environment, equipment and prevention of third party interference and
- comprehensive energy procedures and equipment.

There are other issues relating to pipeline transport

THE PIPELINE MODE-DEVELOPMENTAL ACCOUNT

The ancestry of pipeline transportation can be traced, according to the Organization of the Petroleum Exporting Countries, OPEC[3], to the activities of the Chinese who used oil from natural seeps as fuel to boil salt. They invented the oil pipeline, using lengths of bamboo to take oil to the salt pans and to transmit natural gas to light their capital, Peking, as early as 400BC. From that point onwards, notable milestones in pipeline technology include the common use of cast-iron pipelines in the eighteenth century ; the nineteenth century advent of the steel pipe; the application of welding to join pipes of the 1920s which made it possible to construct leak-proof,

high-pressure large diameter pipelines, introduction of ductile iron and large diameter concrete pressure pipes for water since 1950 and use of Polyvinyl Chloride (PVC) pipe sewers.

Other remarkable advances in pipeline technology: Use of pipe to clean the interior of pipelines and to perform other duties; batching of different petroleum production in a common pipeline; application of catholic protection to reduce corrosion and extend pipeline life; use of space-age technologies such as computer to control pipelines and microware stations and satellites to communicate between headquarters and the field; new technologies and extensive measures to prevent and detect pipeline leak and the invention of pipeline construction facilitators such as large side booms to lay pipes, machines to drill under rivers and roads for crossing, machines to bend large pipes in the field and X- rays to detect welding flaws.

Over the years, different types of pipelines have come to be in existence, according to Pipeline 101[4]. Categorized on the basis of use, the more prominent types are as follows.

Water and sewage pipelines: These are used universally to carry water from treatment plants to individual household or buildings. Domestic sewage which normally contains 98% water and 2% solid are carried away in pipelines.

Energy pipelines are generally of two types- oil pipeline and natural gas pipeline. Oil pipelines, within their network, feature both crude and product lines. While the former carries crude to oil refineries, the latter transports refined products from the refineries to the market. Crude oil lines are relatively short haul movements, although large volumes of crude can be shipped many hundreds of miles to inland refineries[5]. Examples of crude oil lines are the American Capline pipeline that transports over one million barrels per day (bpd) from the Gulf Coast to Southern Illinois crude oil hub; Nigeria's 33 km, 24-inch pipeline from Bonny Terminal to Port Harcourt refinery and the Trans Arabian Pipeline of 1720 kilometres.

Crude oil lines are further subdivided into gathering lines and trunk lines. Gathering lines consist usually of very small pipelines of from 2 to 8 inches in diameter in oil fields. These small lines gather the crude from many oil wells, both onshore and offshore and are connected to large trunk lines measuring 8 to 24 inches in diameter. Trunk lines include a few very large lines, such as the Trans Alaskan Pipeline (TAP) system which is 48 inches in diameter. The large cross country crude oil transmission pipeline brings crude oil from producing areas to refineries. There are approximately 55000 miles of crude oil trunk lines in the US and 95,000 miles of refined product lines in US[5].

Gas pipelines are another division of energy pipelines, with the world's most sophisticated and largest network in the US. The Interstate National Gas Association of America (INGAA) estimates that there are 278,000 miles of transmission lines in the country, including 20,000 miles of natural gas gathering lines that move natural gas to large cross- transmission lines.

Other fluids transported by pipelines include liquid fertilizers, liquefied natural gas and carbon dioxide.

Slurry pipelines have also evolved in the course of versatile application of pipeline transportation. Slurry is a mixture of solid particles and liquid, especially in mining and dredging industries. The worlds, longest coal- slurry pipelines is the Black Mesa pipeline in the US. Built in 1970, this 18-inch pipeline transports 4.8 million tons of coal per year from Black Mesa. Arizona, to southern Nevada, over a distance of 273 miles.

There is another class of specialized pipelines called pneumatic pipelines. Also known as pneumatic transport, pneumatic pipelines transport solid particles using air as the carrier medium. Because air is free and exists everywhere and because it does not wet or react chemically with most solids, pneumatic transport is preferred to hydro transport for most cargoes wherever the transportation distance is short. Common applications include the loading of grains from silos or grain elevators to trucks or trains parked nearby, transport of refuse from collection stations to processing plants or from processing plants to disposal sites, transport of sand or cement to construction sites and transport of coal from storage bins to boilers within a power plant.

Capsule pipelines have now emerged also as an entirely exclusive variant of pipeline transport. This type transports freight in capsules propelled by a fluid moving through a pipeline. When the fluid is air or another gas, the technology is called Pneumatic Capsules Pipeline (PCP) and when water or another liquid is used, it is termed Hydraulic Capsule Pipeline (HCP). The largest PCP in the world is LILO-2 in the Republic of Georgia, which has a diameter of 48 inches and a length of 11 miles. The system was built for transporting rock. In 1991, the US established a Capsules Pipeline Research Centre at the University of Missouri in Columbia. Such investment in pipelines and their rapid and pervasive development is easily justifiable, compared to other modes.

PIPELINE AND OTHER MODES-COMPARATIVE ECONOMICS

Over the years, the economy of the pipeline over other modes of transportation has been established empirically. The American Association of Oil Pipelines by AOPL[6], analyzing shifts in petroleum transportation, finds that, of a total oil transport of 6,400 Billion Board Miles (BBM), rail accounts for 2%, trucks 3%, water carriers 27% and pipelines 68%. This distribution is attributable to relative cost economics. Wilson[7] states that oil pipeline shipments account for more than 17% of the total freight moved nationally in the US but less than 2% of the national freight cost!.

Carrying the comparison further, Trench[5] is of the persuasion that, assuming each truck holds 200 barrels (8.400 gallons) and can travel 500 miles a day, it would take a fleet of 3000 trucks, with a truck arriving and unloading every 2 min, to replace a 150,000 barrel per day, 1000- mile pipeline. This is without prejudice to the fact that in road transportation of petroleum, trucking costs escalate sharply with distance. In the study of railways, while it cannot be incontrovertibly stated that costs rise sharply with distance traveled, their costs still remain a multiple of the pipeline alternative. Trench[5] states that replacing the same 150.000 barrels per day pipeline with a unit train of 2000-barrel tank cars would required a 75-car train to arrive and be unloaded daily, after returning to the source empty, along separate tracks to be refilled.

There is no doubt that waterborne shipments can be priced competitively with pipelines. Their major limitation, however, is geographical, while geographical inflexibility is a chief advantage of pipelines. The pipeline enjoys other comparative advantages which are not necessarily economic. The following tabulation by the Chartered Institute of Logistics and Transport (CILT) provides useful insight.

Dacon[8] states that the fundamental financial characteristics of a pipeline are high initial capital costs, high element of fixed operation costs and relatively small element of variable operating costs and still concludes that the unit cost per ton moved by pipeline will almost always be cheaper than competing modes before taking into account the cost of financing construction. The longer the journey length, the higher the throughput and the longer the period for which high throughput can be reasonably forecasted, the more likely it is that the benefit of low operating cost will justify high initial capital expenditure when compared with alternative modes of transportation.

Studies by Nigeria's Pipelines and Product Marketing Company show that per unit of production measured in billion tons units per ton mile (BTU/TM) for different modes is as follows: air 37000; rail 2300; road 700; water, 500 and pipeline, 150. Pipelines also rank ahead of other modes in safety. According to World Bank[9], in 1981, only 1.3 m^2 of oil was lost per million cubic metres moved by pipeline in Western Europe. This is corroborated by Petrostrategies[10], which indicates that, in respect of volatile products generally, such losses are as high as 0.3 to 0.5% in rail and road transport systems, as against pipeline transport that is only 0.1%. A 1975 study confirms that, beyond 25 miles from refineries in UK, pipelines are 7-8 times cheaper than road and 3 - 4 times cheaper than water and rail. In the US, when compared to other modes, pipelines carry approximately 67% of the ton-mile annually and 17% of all US freight while costing only 2% of the nation's freight bill.

The pipeline is also ahead of the other modes on the environmental front. Environmental degradation and atmospheric population have become so pandemic that the Global Environmental Facility (GEF) at a world level and the Nigerian Environmental Study and Action Team (NEST) at the national level have more or less become weeping prophets. Pipelines respect these concerns by being laid below ploughing depth (1 metre) of the land. They are not affected by surface fog etc. Pipelines have no dead weight to be carried to destination and no empty return carriage costs. They are relatively secured and can be used strategically in times of civil or national emergencies.

Nevertheless, pipelines, cannot be installed and operated without incurring some disadvantages.

DEMERITS OF PIPELINE TRANSPORTATION

Cost is the first factor on which count the foregoing comparative advantage of the pipeline is punctuated. It is known that pipeline construction is associated with high initial capital investment of about $670, 000 per kilometer irrespective of terrain and diameter[8]. Much of the capital cost goes into solving the problem of line fill. There is a further problem of inflexibility as input/exit points are fixed, so that total operation is dependent on the integrity of the pipeline. Also, the normal requirement for lead time is in the neighbourhood of three years for legal way leaves, design and commission, etc. In some situations, moreover, interfaces generated between products can cause significant cost in undertaking disposal and blending processes at the refineries and terminals.

Finally, pipelines are associated with a situation in which variable cost rises steeply when throughput goes above a certain level and eventually, far outweigh the reduction in the fixed cost in the make-up of total cost per unit of transportation.

CONCLUSION

Historically , the pipeline follows the waterway as the earliest mode of transportation. It has developed through many stages, over the years and currently finds a wide variety of uses in the movement and conveyance of outright liquids and fluids, semi-fluids and even whole solid cargo.

The versatility of the pipeline is predicated on its environmental friendliness, its relative safety and security and above all, the advantage of the favourable comparative economics that surround it.

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