BRANDSTOFNAVORSINGSINSTITUUT

VAN SUID-AFRIKA

FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA

TEGNIESE
TECHNICAL MEMORANDUM NO. 22 OF 1971

PIPELINES FOR SOLID MATERIALS

OUTEUR:
AUTHOR: G.A.W. VAN DOORNUM

Cosml 4100 B 56

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

TECHNICAL MEMORANDUM NO. 22 OF 1971

PIPELINES FOR SOLID MATERIALS

1. INTRODUCTION

The following notes are extracted from a paper presented by A.H. Kloosterman at a meeting of the Royal Netherlands Institute of Engineers on 19th November, 1970 and published in "De Ingenieur" of 2nd April, 1971.

In this extract, particular emphasis is laid on the transport of solid materials by pipeline.

2. GENERAL CHARACTERISTICS OF PIPELINES

The main advantages of pipelines may be briefly mentioned; these are

a) Immunity from interruptions of the service by the vagaries of the weather; in fact it requires a major natural disaster to put a pipeline out of commission.

b) Where large volumes of liquids have to be conveyed on land, a pipeline offers the most economic, and frequently the only practicable method. For gases, no alternative exists unless the quantity involved is minute. Even for solids, a pipeline may now offer the most economic solution for large quantities and long distances.

c) The manpower requirements are very low and the process is well amenable to automation.

d) The wear of the pipeline itself is very low and its life virtually unlimited. The auxiliary equipment, such as the pumps, require some maintenance, but the cost itself is low.

e) The space requirements of the pipeline are very small, the ground above the line remains available for many purposes. Crossing a mountain range poses no problems and the shortest

/route .....

route can be followed over most of the distance.

f) The time of construction is extremely short as compared with that for railway lines or tankers of the same carrying capacity.

Attention should, however, be drawn to the special characteristics of pipelines. The most economic operation is attained at a specific load and very little variation can be allowed here. Adequate storage facilities at the intake and terminal must thus be provided. The pipeline must always remain filled so that in the case of an oil pipeline, the large volume inside is not available for consumption. (In the case of the S.A.R. crude oil line, this quantity is of the order of 100 000 tons.)

The usual velocity in the pipeline is 2 ... 2,5 m/second (approx. 5 miles per hour) for liquids and 20 m /sec for gases. However, due to the low density of gases, even when considerably compressed, gas pipelines have less carrying capacity than liquid lines and the construction of the line is, because of the higher pressures, more expensive.

The quality of the steel used for pipelines has been considerably improved and some experimental pipelines are now made of steels having a yield strength of 550 N/mm^2 which is more than double the figure of the material used some 20 years ago. The welding equipment, required to join sections in the field, now frequently operates automatically.

3. PIPELINES FOR THE TRANSPORTATION OF SOLIDS

It has been known for a long time that solids in suspension can be conveyed in a pipeline, though most of the older projects only involved transportation over short distances. Recent developments have, however, made it possible to convey solids over very long trajects and in cases where the material has to be comminuted in any case at some stage of the manufacturing process, this method of conveyance can well be competitive with the conventional means of transportation. Further, experimentation with encapsulated solids, which thus could be of any

/size .....

size, commensurate with the diameter of the pipeline, is in progress. This method, however, has not yet been applied in practice (apart from some pneumatic conveyance systems as used for messages and small parcels).

However, sufficient data on the transmission of suspensions to permit an economic assessment are now available. Figures 1 to 3, reproduced from the original paper, supply interesting information in this respect.

Figure 1 indicates that the heavier materials require less water (by weight) to form a pumpable suspension, which is reflected in lower transportation costs.

Figure 2 gives various costs for the conveyance of sulphur, suspended in a liquid petroleum product. From these data, it may be calculated that the cost of preparing the suspension is of the order of R1-10 per ton*. At 600 km, preparation and transmission costs are approximately the same.

Figure 3 supplies the total cost (i.e. preparation, dewatering, and transmission costs) for coal. Unfortunately the distance involved is not indicated; this appears to be some 500 km.

According to Figure 2, the pure transportation cost for coal, at the rate of 6 million ton per year, would be 0,18 (S.A.) c/t, km or R1-44/t for a distance of 800 km, roughly corresponding to the distance Witbank-Richards Bay.

To this figure, the cost of preparing the suspension should be added, but it is possible that a very simple dewatering process would suffice for coal, loaded into a vessel.

/Studies .....

---

*The data for the shortest distance, 100 km, do not fit in very well, but for the longer distances a reasonably consistent figure for the preparation cost is obtained.

Studies by the Marcona Mining Company[1,2] have indicated that it is entirely feasible to pump iron ore into a normal oil tanker and to remove most (up to 92%) of the water by pumping from the vessel. Prior to unloading the cargo, water is again added to obtain a pumpable product. Some care must obviously be exercised to avoid overloading the ship.

These studies indicated further that loading and discharging times could be reduced to a fraction of the times necessary when using conventional methods and that the cost of these operations could be reduced to 10% of the normal figure.

If normal oil tankers were used for the conveyance of coal and ore, it may frequently be possible to arrange shipping movements in such a manner that a paying cargo is carried most of the time. (Oil on the way in, ore etc. on the outward journey.) Moreover, special ports for large vessels would not be required as a buoy would suffice. Three of these multi-purpose tankers (of 130 000 ton carrying capacity) are at present under construction in Japan.

Slurry pipelines are now considered to be completely reliable. A project in Arizona was recently completed where a pipeline of 440 km, 18" diameter, forms the only supply system for a 1500 MW power station, consuming 6 ... 7 million tons of coal per year. This Black Mesa pipeline traverses mountainous country and rises from sea level to 1800 m. The system operates automatically and one man controls the slurry preparation, the pipeline, and 4 pumping stations. The total cost, including that of the power station, was $200 million, of which $35 million was for the pipeline. A useful life of 35 years is anticipated and depreciation is based on this period.

Similar confidence in a slurry pipeline was shown in Tasmania, where the successful investment of a R50 million iron ore mining project entirely depends on the operation of the pipeline. A large number of stops and starts have confirmed the reliability of the system.

The feasibility of an 800 km pipeline in British Columbia, having a capacity of 12 ... 18 million tons of coal

/per .....

per year (for export to Japan) is now under study.

Table 1 supplies some data on major projects, now in operation, under construction or in the planning stage.

TABLE 1

PIPELINES FOR THE TRANSPORTATION OF SOLIDS

Situation	*	Material	Length, km	Diameter, inches	Capacity, 10^6 t/a
Ohio	a	Coal	174	10	1,3
Utah	a	Gilsonite	116	6	0,38
England	a	Limestone	92	10	1,7
Colombia	a	Limestone	14,5	5	0,35
Trinidad	a	Limestone	9,5	8	0,57
S. Africa	a	Gold mining waste	35,5	6, 9	1,05
Tasmania	a	Iron ore concentrate	86	9	2,25
Arizona	a	Coal	439	18	4,8
Japan	a	Copper mining discards	64,5	8	1
Japan	a	Ore discards	69	12	0,5
Canada	c	Sulphur/hydrocarbons	1287	12 ... 16	
Canada	c	Coal	810	24 ... 30	12 ... 18
New Guinea	b	Copper ore concentrate	110	3	0,3
Africa	b	Phosphates	5	12	5
Australia	c	Coal	225	24 ... 36	12+

*a: In operation b: Under design c: In planning stage

These data may show that slurry pipelines have definitely left the experimental stage.

(SIGNED) G.A.W. VAN DOORNUM
CHIEF RESEARCH OFFICER

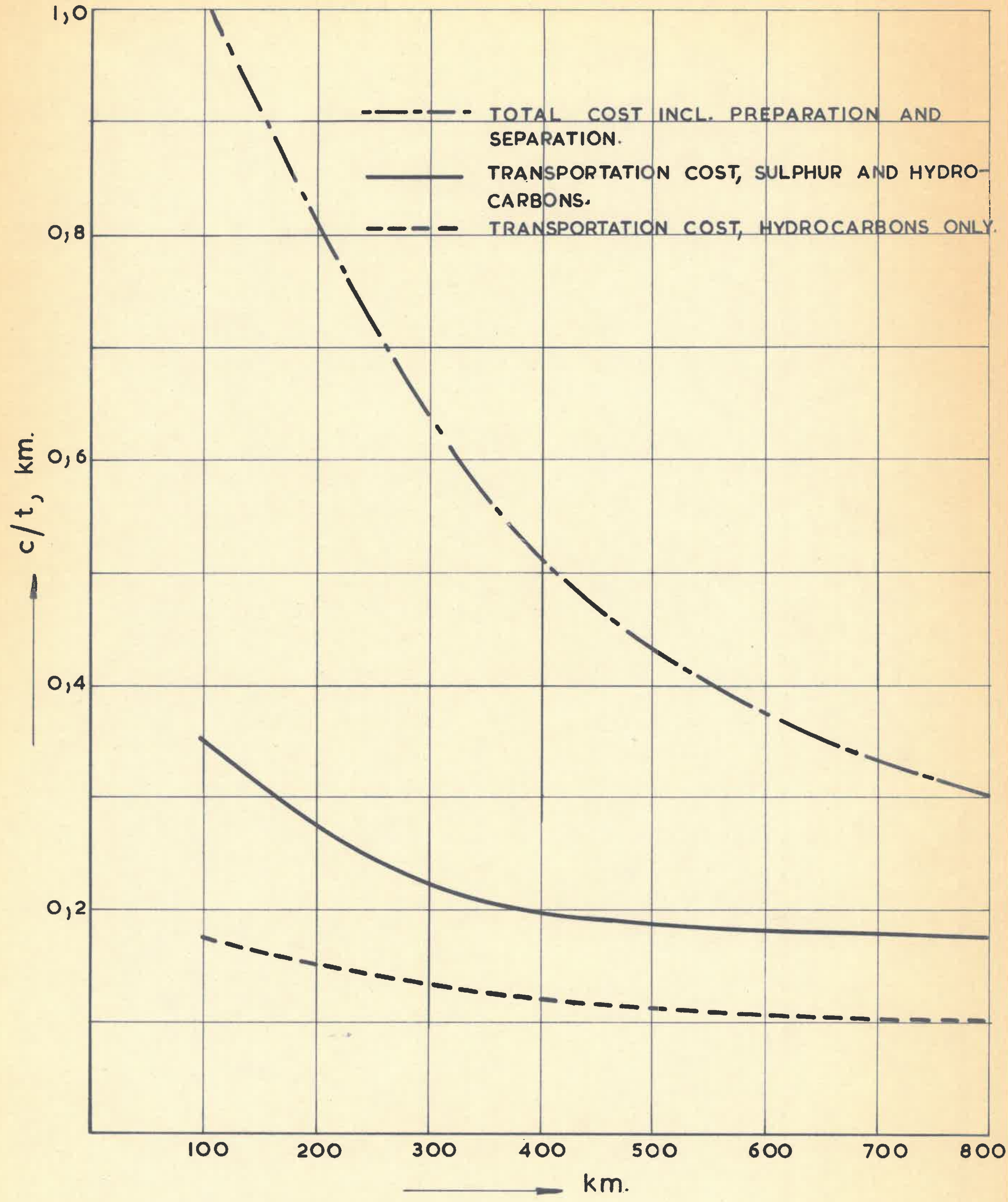
PRETORIA.
21st May, 1971.
/TW

LITERATURE REFERENCES

1. Pipeline and Gas Journal, July 1970.

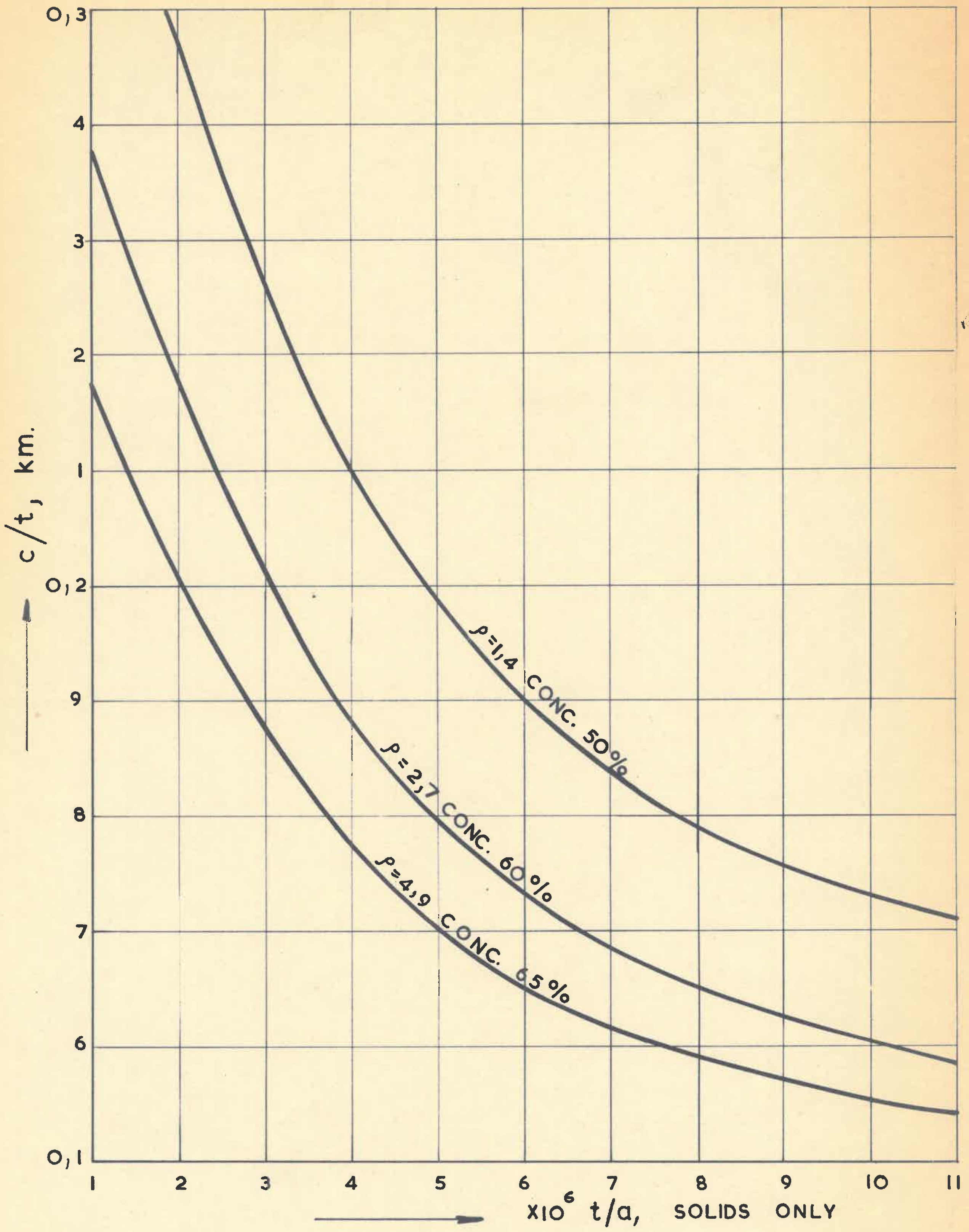
2. Pipeline Industry, Aug. 1969.

FIG. 1



TRANSPORTATION OF SULPHUR [$3 \cdot 10^6$ t/a] WITH LIQUID HYDROCARBONS

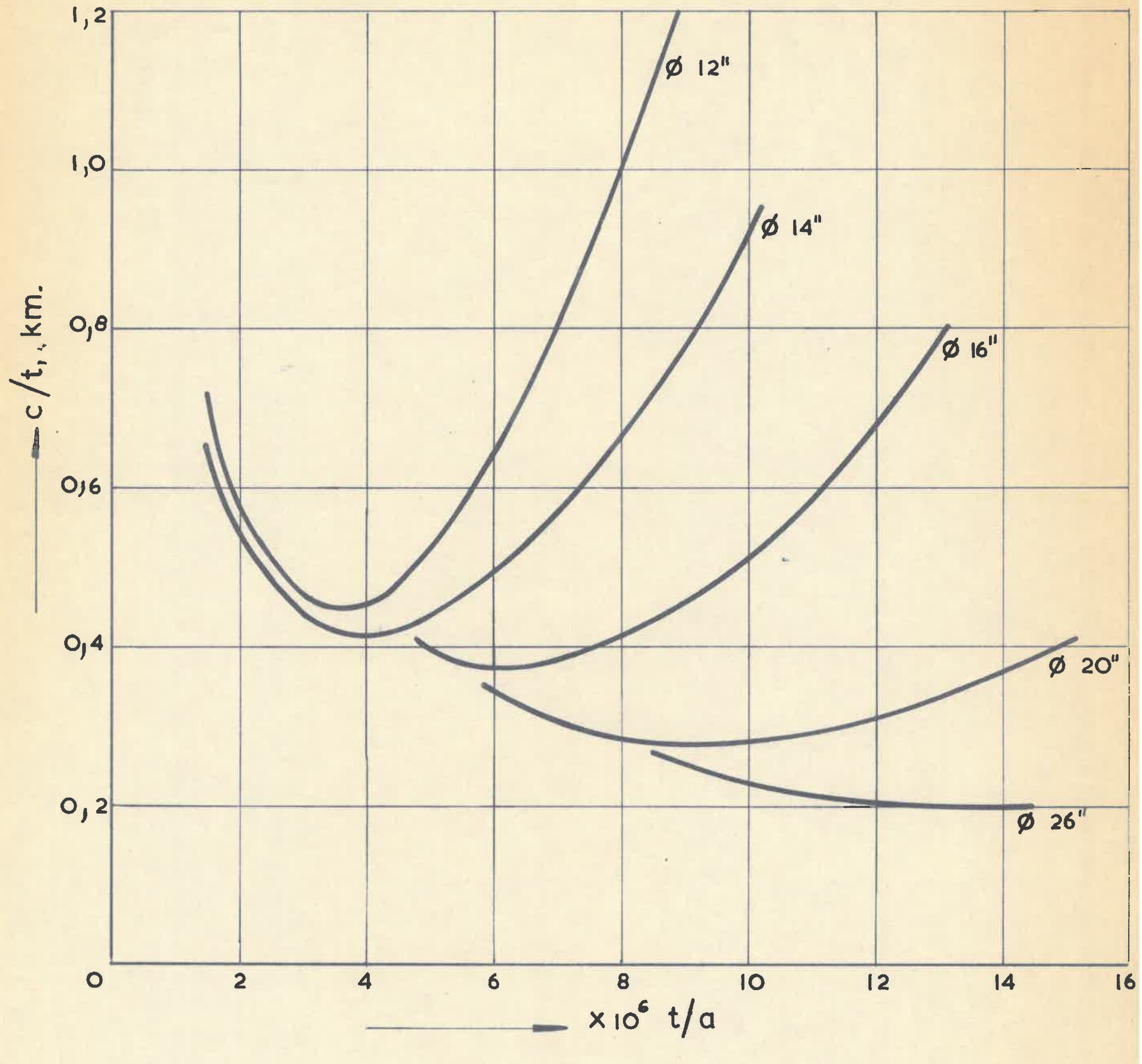
FIG. 2



TRANSPORTATION COST, EXCLUDING PREPARATION AND SEPARATION

ρ = DENSITY OF SOLIDS, CONCENTRATION PERCENTAGE BY WEIGHT

FIG. 3



TRANSPORTATION COST OF COAL, INCL. PREPARATION AND SEPARATION