

UTILIZATION OF MOLASSES

By C. W. PETCHELL

Mr. Petchell read his paper on the above subject, as follows:—

Up to about seven years ago, the question of the utilization or disposal of molasses had always been a troublesome one for the millers of Natal and Zululand.

Some of the mills had distilleries which used up a portion of their molasses, but these were worked in a very crude way, with no scientific control of the fermentation, and only produced a low-grade spirit known as Natal Rum, for which there is only a limited market.

There were various methods of disposing of the surplus molasses, amongst which were:—

1. Running it on the land.
2. Burning it on the bagasse in the furnaces.
3. In some of the small mills advantageously situated, doing a lucrative trade with the natives for cash or in exchange for mealies.

The drawbacks to running it on the land are many. In the first place the bulk of the molasses are being produced when the mills are crushing. At that time all the rolling stock, animals and labour are usually so busily employed bringing cane to the mills that the owners do not want to be bothered with the job of distributing it on the land if other means of getting rid of it can be found. Also every mill has not the ground available for applying it. In many cases it has happened that the molasses have been put in trenches in hilly ground, a heavy rainstorm has come along washing the molasses into the nearest stream with the consequent pollution and destruction of fish.

Several mills have tried the second way, sprinkling it on the bagasse at the entrance to the furnaces. This at first appeared to be a good way of getting rid of it, but it was soon found that the potash in the molasses attacked the firebrick lining of the furnaces, forming large pieces of clinker which stuck to the sides. When these were detached they generally brought away a portion of the firebrick lining with them. If they were not detached they speedily reduced the grate area very considerably.

During the war when the price of potash rose enormously, it was proposed to burn the molasses in special furnaces for the recovery of the potash. With the price of potash as it is to-day I do not think that it would pay to do this.

As the sugar production in Natal went on increasing by leaps and bounds it became more and more difficult to utilise or dispose of the waste molasses.

About seven years ago the United Molasses Co., Ltd., appeared on the scene and formed a branch here under the name of the Pure Cane Molasses

Co., Ltd. This company has for the past few years taken all the surplus molasses. This took a burden from the shoulders of the millers at the same time securing a satisfactory revenue to them.

Their contract has now expired and may not be renewed, at any rate not on the same advantageous terms. It therefore behoves the millers to look for other outlets. After many years experience I have no hesitation in saying that the best scheme at the present time would be the manufacture of motor fuel on a large scale.

The Natal Cane By-Products, Ltd., started making Natalite, an alcohol, ether, motor fuel at the end of 1917. They proved conclusively that many of the objections raised against alcohol fuels did not exist, and that no damage whatever was done to the cylinders or working parts of motor engines by the use of same.

In some cases where the supply tanks were zinc coated the fuel attacked the lining, although it did not occur in the majority of cases. This trouble increased when the use of die cast zinc castings for carburettors, etc., became general about three years ago. Exhaustive experiments were made and a means was found to alleviate this trouble, although we were not able to entirely remove this. Our experiments showed that the trouble could only be completely removed by the use of absolute alcohol.

Less than ten years ago absolute alcohol was considered to be a product of the laboratory, and could only be prepared by the old quick lime process.

The necessity for a cheap method of producing absolute alcohol in bulk at a cheap rate led to the discovery and development of the Ricard Allenet process by the Société Anonyme des deux Sevres. This process is based on the discovery of Professor Young in the early part of the present century.

Ordinary processes of distillation do not produce a spirit of over 95 to 96 degrees strength. Spirit of this strength will not mix with petrol to any extent without the use of a mixing agent such as ethyl ether or benzol.

For some years past in Natal ethyl ether has been used as the mixing agent. The use of absolute alcohol does away with the need of a mixing agent as it is miscible with petrol in any proportions. The use of ether had certain advantages such as raising the vapour pressure, thus making for easy starting, but its great volatility was apt to render the fuel unstable if exposed to the high temperatures sometimes prevailing out here.

After exhaustive experiments lasting over several months, the Natal Cane By-Products, Ltd., decided to order a plant to manufacture absolute alcohol under the Ricard Allenet patents. After several unfortunate delays the plant was delivered and

started up about the middle of February under an expert sent from the patentees. This plant is a complete success and is capable of producing 2,000 gallons of 100% alcohol per day. A mixture is now being marketed consisting of absolute alcohol and petrol without any ether. No difficulties have been experienced in starting; at the same time, if any difficulty in starting in the colder districts occur, a small percentage of ether can be added, although we do not recommend it for the coast of Natal.

One of the main advantages of an absolute alcohol petrol mixture is its anti-detonating properties, it being possible to run an engine with a compression as high as 10 to 1 without any pre-ignition. When one has once driven a car with the mixture, one never wants to get back to plain petrol on account of the greater flexibility, increased power and smoother running of the engine.

During the years following the war, stocks of alcohol on the Continent of Europe increased rapidly owing to the cessation of the demand for munition purposes.

The problem of the disposal of these stocks appeared to be a very difficult one; the discovery of a cheap method of manufacturing absolute alcohol, and sympathetic Governments soon removed the difficulty.

In France, Italy, Czecho-Slovakia, Hungary and Poland, the various Governments have taken up the question of the disposal of surplus stocks of alcohol, whilst Austria, Lithuania and Jugo Slavia are expecting to follow suit within a very short time.

In France the disposal of the surplus alcohol is in the hands of a Government Department under the name of the Service of Alcohols. This department is under the War Minister, who allots to the War Department whatever alcohol is required for munitions, etc. The remainder has to be taken by the Petrol Companies to mix with petrol up to a proportion of 10 per cent. alcohol to 90 per cent. petrol. So far there has not been enough surplus alcohol to reach this percentage.

In Hungary the National Society for the Marketing of Alcohols takes charge of the surplus. Since September, 1929, the mixture of absolute alcohol and petrol is compulsory, in spite of the opposition of the Petrol Companies. This fuel is marketed under the name of Motakol.

In Germany a law was passed in April, 1930, which took effect in July, 1930, making the admixture of absolute alcohol with petrol compulsory. The marketing of alcohol is in the hands of a Government Department called the Monopole. The importers of petrol are compelled to buy a certain

quantity of alcohol from the Monopole. This percentage is fixed provisionally at 3 per cent. The mixed spirit is sold as "Monopoline."

In Italy the admixture of alcohol with petrol is compulsory, but no details are to hand yet.

Last year the sugar crop in South Africa produced 393,000 tons of sugar. The present crop should produce a good deal more. If it only produced the same as last year there should be at least 20,000,000 gallons of molasses for disposal, i.e., enough to produce 7,000,000 gallons of absolute alcohol. As the importation of petrol for the last twelve months was about 70,000,000 gallons, a 10 per cent. mixture would absorb all the alcohol that could be made.

There is also the question of surplus wine to be considered. I do not know exactly what the figure is but think that at least 1,000,000 gallons could be made from this source, with benefit to the wine-growers.

If we can get the promise of help from the Union Government on similar lines to those followed by the majority of the Governments of Europe, a big scheme to utilize the surplus molasses could be put in hand at once. There is no experimental work to be done. We know exactly what plant is wanted and costs of production.

The scheme should be based upon a combination of the whole of the sugar interests and should be preferably owned by them. In this case the profits could be shared amongst the suppliers of molasses.

If the Sugar Industry is not prepared to take up the whole of the capital, a portion could be offered to the public in the form of preferential shares at say 8%, the balance to be taken up by the mill owners, amongst whom all profits after the payment of interest to the preference shareholders would be divided.

It would be necessary to erect a large distillery up the North Coast, probably near the Tugela, where an ample supply of water would be assured. The plant at Merebank could take the molasses from the South Coast and if necessary be duplicated to take all the molasses within a radius of say 50 miles.

Such a scheme would keep a lot of money in the country and help to preserve the balance of trade, at the same time it would employ a number of people.

There are no insuperable difficulties to overcome, but to make a complete success of it; it should be done in co-operation with the whole of the Sugar Industry, who would have to pull together as one and sink all petty jealousies and differences of the past.

ADDENDUM.

When I wrote the foregoing I estimated the amount of petrol imported as 70,000,000 gallons, the same as 1929. The official figures have now come to hand, which show that there was only about 65,000,000 gallons imported in 1930, a decrease of 5,000,000 gallons.

During the past few days I have received details concerning the use of absolute alcohol in Poland. The disposal of the alcohol is in the hands of a Company called the "Polmin." When surplus alcohol is available the petrol companies have to buy and mix up to 30% of absolute alcohol with their petrol. The price to be paid for this alcohol is fixed by the Government.

In Hungary there are five absolute alcohol plants at work producing about 14,000 gallons per day. The total production for last year was between 2½ and 3 million gallons.

France last year produced 12,000,000 gallons of absolute alcohol for motor fuels. This is likely to greatly increased in the near future owing to the large over-production of low grade wines.

The following is an extra from "Weekly Sugar Notes," dated 19th February, 1931, received in Durban last week:—

"EUROPE.

"POSITION OF POWER ALCOHOL.

"Dr. Georg Kaltenbrunner of Vienna contributes to the February 'FACTS ABOUT SUGAR' an exclusive survey of the production and use of alcohol for motor fuel in Europe. He points out that during the War it was much used instead of petrol. After the War the desire to be independent of foreign supplies led more and more countries to use alcohol fuel though it could only be used practically for motors in mixture with gasoline or benzoline. Leading experts to-day, he says, hold that a judicious mixture of alcohol and gasoline gives an excellent motor fuel, which improves the performance of the motor and reduces the fuel consumption below that of gasoline used alone. The best proportion of alcohol is considered to be between 20 and 30 per cent. Alcohol, therefore, must at present be regarded not so much as a substitute for gasoline as an ingredient of an improved fuel.

"In Europe fuel is distilled from agricultural products (potatoes, cereals and sugar beets), from molasses and from the waste liquor of sulphite pulp production. Molasses is used largely in Austria, Hungary, Germany, France and Italy.

"In view of the low molasses prices now prevailing, the molasses alcohol industry at the present time should be in a position to increase its pro-

"duction of alcohol for fuel use at prices which would enable it to compete with other motor fuels.

"The use of alcohol as a motor fuel is regulated by law in most European countries where it is employed to any extent, the control extending in many cases to control of prices. The consumption of alcohol as motor fuel in the countries in which it is extensively used for this purpose (France, Germany, Czecho-Slovakia, Sweden and Poland) amounts to about 19,500,000 gallons and probably will soon reach 26,000,000 gallons."



CHAIRMAN: Mr. Petchell has given us a paper which is full of promise for our big problem of utilising molasses. As he points out, this thing has been not only tackled, but tackled successfully in Europe on a basis which seems to hold out no peculiar difficulties in this country. I presume any country making a product of this sort has to put up a great fight against the oil interests of the world, whose power we all know, but other countries have done it, and it looks as though it is a thing we could very well do in this country with advantage not only to the Sugar Industry but to the whole country itself. You will notice that our Government are continually complaining about the amount of money which is sent out of the country for motor cars and petrol, and many individual Nationalists have proposed limiting motor car imports in order to stop this constant drain on the country's money. If we could get something of this sort we will be doing a double good. The problem of disposal of molasses we all know is a very acute one, and here we have a very sound proposition. I hope there will be a full discussion on this, and that Mr. Petchell will be able to give us some useful information. He speaks of a 10 per cent. mixture being adequate to take up all our stocks, but we have to look to our stocks being larger in the future, and I would like to know whether he considers 20 per cent. mixture in this country would be advantageous, and whether the commercial value of it is such that it might pay us to utilise a certain amount of our stocks of surplus sugar for this purpose rather than export it at tremendous loss.

Mr. PETCHELL: The European countries use up to 30 per cent. and 40 per cent., but many of them have not enough to go up to even 10 per cent., but as the supply of alcohol increases no doubt they will increase the amount. With regard to the question of using sugar it would have to be at a very low price to be able to turn that into absolute alcohol to compete.

Mr. DYMOND: Can Mr. Petchell tell us if the admixture of say 20 per cent. absolute alcohol would in any way affect the price of petrol; would it lower

it in any way, and again; are the same denaturants used in this mixture of petrol and alcohol as were required by the Government in the production of Natalite?

Mr. PETCHELL: No, the Government have been very good; they allow a $\frac{1}{4}$ per cent. of pyridine and the petrol is sufficiently denatured in the mixture.

Mr. DODDS: I think it is eloquent of the present lack of organisation in chemical industry that a valuable substance like molasses should be almost a drug on the market at the present day. It rather reminds one of the position in the coal distillation industry many years ago when coal tar was a by-product and a drug on the market, but is now one of the most valuable products from coal. It does seem extraordinary that a substance full of carbohydrates should be so largely wasted as it is in this country at the present time. I was specially interested in Mr. Petchell's remarks regarding the present means of utilisation of molasses. He mentioned the fact that at one time it was sold to Natives for local consumption. I believe that one local factory made a good thing selling to Natives at 1/- a time as much molasses as the boy could carry away. But with regard to its edible qualities Mr. Petchell did not mention the fact of which we were reminded last year in a paper by Mr. Fowlie, that it is a valuable stock food, and its possibilities in that direction should always be kept in mind by the Industry. It is, as he points out, a valuable fertiliser, but I think it is too valuable to be used as a fertiliser. It contains mineral salts which probably accounts largely for its fertilising properties, but not solely. However, it seems wasteful to use it as a fertiliser, and rather reminds one of the position that existed in this country a few years ago when the whole of the coal from a certain mine was destroyed merely to use the by-product ammonia as a fertiliser. Using molasses for fertiliser seems to me to be going on the same lines, that is to say we lose to a great extent the valuable carbo-hydrates.

Dr. HEDLEY: Mr. Petchell refers in his paper to the burning of molasses. He says it does not pay to-day; it won't pay in comparison with making alcohol if you sell the alcohol. But if you can't get rid of it it can be burnt, and in burning it there will be a certain amount of valuable by-products. If you take a factory which is manufacturing 43,000 tons of sugar it will make 12,900 tons of molasses, which will give you 1,290 tons of ash, 330 tons of potassium oxide or 480 tons potassium carbonate. These analyses were done for me when I was burning molasses, by Kynochs. Potassium carbonate at £25 a ton will give you a gross yield of £12,000. But to burn it is not an easy matter, and I spent a year and a good deal of a certain Company's money in trying to build a furnace to burn it before success was attained. But apart from the value of the potassium carbonate in the

molasses when burnt, there is also the value of the B.T.U.'s. The B.T.U. of a pound of molasses is 4,500 and of a pound of bagasse 3,500. This heat is equivalent to about 600 tons of coal, and as a subsidiary fuel it is therefore very valuable, so there is something in burning molasses provided you are not in a position to get rid of it. It is a wicked thing to do though, and I agree with Mr. Dodds.

It is interesting to compare the output of alcohol from molasses with that from other sources. During the War Australia set up a Committee to investigate this, and these were the results. The Executive Committee of the Australian Advisory Council of Science and Industry in 1916-17 gave the following approximate yields of alcohol under working conditions—yield 95% alcohol per ton of 2,240 lbs.—

Maize	80—83 gallons.
Wheat	80—85 "
Barley	65—70 "
Potatoes	16—24 "
Sawdust (soft wood)	20 "
Molasses	65—70 "

One bushel of wheat yields 2.5 gallons of 100% alcohol and the average yield of wheat per acre is 26 bushels, therefore to produce 7,000,000 gallons of absolute alcohol 2,788,000 bushels of wheat would be necessary or 107,200 acres of land. If the land were under meales and the South African average yield of 12.5 bushels per acre taken, an area of land would be required *approximately that occupied by the whole sugar belt*. Molasses is one of the best and cheapest sources of alcohol owing to its high content of sugar and the fact that it needs no conversion such as starch requires, but is ready to be fermented immediately after dilution.

Mr. PETCHELL: Dr. Hedley and Mr. Dodds referred to the food value and said it was a shame and a waste to burn molasses, but all over the Continent of Europe they are doing it as they cannot absorb it as a foodstuff. Unfortunately the people of this country don't take to it with the exception of the poultry farmers. As far as potassium carbonate is concerned, the better way is to treat the dunder. That is a question which wants a paper on its own. Instead of extracting it by burning it is better by fermenting the molasses and treating the dunder and making potassium carbonate from that.

Mr. HAYES: This problem of alcohol, or molasses disposal, is, as Mr. Petchell states, one of supreme importance to the whole Industry. However, it would seem that far more active measures should be taken to assure the success of alcohol motor fuel in this country than to sit down and wait for the enforcing of a 10% mixture by the Government. Evidently the Government is not wholly agreeable to this proposition at present, and certainly no help can be looked for from the public.

Motorists are distinctly prejudiced against alcohol fuel, and in South Africa at any rate this prejudice can be accounted for by their experience with "Natalite"; not so much because of any failings of "Natalite" as a fuel, but rather through the lack of knowledge and lack of facilities which the public had for using that fuel. Until a large amount of propaganda work has been done alcohol fuel will only mean "Natalite" to the ordinary motorist. To quote personal experience—on three occasions in the past two weeks I have pulled up at garages and asked for Union Spirit and have been met with the reply that they did not stock "Natalite." To be used successfully in an internal combustion engine an alcohol fuel necessitates at any rate two important changes from petrol practice—carburation must be altered and compression must be raised. Mr. Petchell states it is possible to run an engine with a compression as high as 10 to 1 with an absolute alcohol petrol mixture without pre-ignition. That is perfectly true, but it should be stated also that to run an engine on alcohol fuel and obtain best efficiency the compression ratio must be higher than that used with petrol. It will be understood that within certain limits the higher the compression that can be used in an engine the greater the efficiency. In Europe recently the highest racing successes have been obtained using a compression ratio of round about 16 to 1. Alcohol permits a compression of 15 Kgms. per c.c. without spontaneous combustion which takes place with petrol at 4 Kgms. per c.c. As alcohol only has about half the thermal efficiency of good petrol it will be seen that results will only be obtained when the greater efficiency from increased compression makes up for the lower available energy of the alcohol. The average car as turned out by the makers seldom has a compression ratio higher than 6 to 1, so no advantage will be obtained by using alcohol; in fact, results will not be so good as with petrol. To alter this standard engine and raise compression will undoubtedly help, but will also bring certain bad results. Slow running and pulling power at low speeds will be impaired, and considerably more wear will be imposed on the engine. The modern tendency is towards higher engine speeds and higher efficiency, but a high compression engine is not a very satisfactory thing in the hands of a novice, so we have not yet reached the stage when standard cars call for special fuels. The next point is the difficulty of obtaining perfect carburation with alcohol fuels. Alcohol containing oxygen in its molecule requires less air for its carburation than petrol. Again, alcohol by itself is a bad thing to carburate. It has a low vapour tension and more than four times the heat of evaporation of petrol. Mixed with petrol, of course, results are far more satisfactory, but we still have the difficulty of the smaller amount of air required. To overcome this two things can be done. Fit a larger jet or a smaller choke. To do the latter immediately lowers engine efficiency, and the former will generally

increase consumption. The difficulty is that the ordinary motorist does not know, and is not told, of this. He decides, or is persuaded, to try an alcohol fuel. He makes no changes to his engine. Consequently he suffers all the ill effects of running on too lean a mixture, which are almost equally harmful with "straight" petrol. Valves, valve seats, and pistons are damaged and lubrication is impaired through drying out. Another danger with alcohol is that when imperfectly carburated and burnt incompletely in the form of a fine spray it is liable to form acid products. When the motorist notices these bad results he immediately turns round and blames the alcohol fuel, whereas it is really only faulty carburation that is blameworthy. So you should embark on what might be termed a policy of educational advertising. Before the public use alcohol fuel tell them how to use it intelligently and so overcome the existing prejudice. If this can be done and a price advantage is offered, we will be on the road to obtaining a large home market for alcohol, and therefore molasses, without the present necessity for soliciting Government assistance. Overseas markets will be more difficult. As an anti-detonant alcohol has a serious rival in ethyl petrol. An enormous amount of this spirit is sold annually in America and England. In passing it might be mentioned that ethyl petrol, or petrol and tetra-ethyl lead, has no injurious effects on public health as was stated in a leading Sugar Journal recently. In advertising alcohol fuel the importance of racing successes should not be overlooked, and every effort should be made to foster the support of the racing motorist. In the Isle of Man T.T. Races at present only so-called "commercial" fuels are permitted. Alcohol is barred, but a fifty-fifty petrol benzol mixture is allowed. This demonstrates the outlook that alcohol is a sort of "freak" constituent of a fuel whereas benzol is perfectly normal. This is quite wrong—benzol is expensive, gives bad starting, and according to some authorities is inclined to "dry" the engine. The thing to do therefore is to demonstrate by racing the superiority and adaptability of alcohol fuel, ensure adequate supplies throughout town and country, and I think no fear need be felt for future markets.

Mr. PETCHELL: There are several points that I will leave alone as they have to deal with salesmanship. The old Union Spirit has not been pushed because we were putting the new spirit on the market. We were having tests made at the Witwatersrand University and in Europe. Until we got everything complete we did not want to put the new fuel on the market. Regarding the alteration to the engine mentioned by Mr. Hayes, we want to put on a fuel which will need practically no alteration. With regard to advertising and telling the public about it, that is for the selling agents to see to. I may say that Mr. Hayes has spoken about a lot of dangers which are imaginary. We have never had the acid re-action in the cylinders; that

has been a "bogey" for years and has been scotched long ago. With regard to thermal efficiency, a mixture of fifty-fifty has undoubtedly a lower calorific value, but we have users all over the country who are telling us that they are getting the same and better results. With regard to increasing the compression you can't tell a man he has to increase the compression; you have to make a fuel to use in the present engine. Incidentally, Mr. Hayes said that with extra compression there would be more wear and tear on the engine. I can tell you that with alcohol fuel the detonation is not so sudden and the wear and tear is less than with the petrol. With regard to racing, several of the big races have been won on our fuel and not a "freak" petrol. Cohen is one, and there have been half-a-dozen of the big races won on our fuel which have been absolutely only alcohol and petrol, but as the plant had not arrived then we did not make as much use of those performances as we might have done. Alcohol alone I don't think will ever be a practical standard fuel. The whole of the busses in Paris are running on fuels similar to what we are making to-day. The Durban Corporation have now got several busses running on it. You must remember you can't push a thing like this all at once. We have only been making this absolute alcohol three weeks, and we wanted to issue it privately as much as possible and get the opinion of users before advertising it extensively or pushing the sale largely.

Mr. HAYES: I was not implying that alcohol was a freak constituent of a motor fuel, but was trying to show that that is the point of view of some people. The Isle of Man T.T. officials state only commercial fuels can be used. Over there they regard petrol benzol as commercial fuel. What I was driving at was: Why should they regard petrol benzol as such a fuel and not petrol alcohol? It only means they have not got sufficient knowledge of alcohol petrol mixtures, and there is not a big enough supply for them to be able to term it a commercial fuel. When that can be done and successes of that magnitude can be obtained by alcohol fuel undoubtedly the public will get to know more of the fuel and use it more.

Mr. PETCHELL: It only came in in Germany in July, 1930, and the British Isles are generally very slow in adopting anything.

Mr. HAYES: In regard to the acid re-action I was not speaking so much of the present absolute alcohol petrol mixture, as the past mixture "Natalite" or similar fuel consisting of alcohol ether. Mr. Petchell states there was no trouble with acid re-action there. In an engine running perfectly and properly tuned for that spirit undoubtedly there would be no acid effects, because all the spirit would be burnt up, but where the carburetter was not adapted for that fuel undoubtedly there were these effects. If there was no fear of this acid re-action, why was the addition of an alkaline base necessary? There is a paper published in the Louisiana Planter and Sugar Journal where a spirit called "Ethylite" is compared with "Natalite." The writer states there that advantages were obtained, but where there was an acid re-action this ammonia base was retained by the "Ethylite" whereas it may be volatilised in the "Natalite" before use.

Mr. PETCHELL: That arose through the original Natalite Syndicate being afraid of this, and they put in the patent rights half per cent. of ammonia was to be used. I promptly left it out because I found the pyridine base liberated enough ammonia without anything else. In the early stages the Government insisted on wood naphtha. That had a serious effect. We brought that before the Government and they allowed us to remove that. Possibly there is a lot in what Mr. Hayes says, but a lot of it is a "bogey" and has not proved a real danger.

Mr. HAYES: That is what I am driving at; it is a "bogey" so far as the ordinary motorist is concerned. He has heard of that, and the thing is to popularise the new product.

In reply to Mr. ASKEW, Mr. Petchell stated it was not necessary to alter the carburetter with the new fuel.