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SCP PRODUCTION FROM METHANOL1/

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SUMMARY

MGC pioneered to utilize natural gas as feedstock to manufacture methanol, and the company enjoys the largest production scale of the product in Japan.

MGC started joint research on the commercial production of single cell protein (SCP) based on methanol with the Fermentation Research Institute (FRI) of the Ministry of International Trade and Industry since 1969.

A large scale pilot plant which is under construction is expected to be completed in the middle of 1974. MGC possesses several different isolates of heat torelant yeasts, which can be cultivated at approximately 40°C, as well as bacterial isolates of considerably high yield value. The company has been endeavouring to develop their use as feed for fish and animals as well as industrial use, and at the same time carefully proceeding with their safety tests. We are confident that MGC methanol protein can sufficiently be used as protein source for feed.

MGC SCP Production from Methanol

I. Introduction of Mitsubishi Gas Chemical Company, Inc.

We, Mitsubishi Gas Chemical Company Inc. (hereinafter called MGC), are one of the large chemical companies of the Mitsubishi group. Among them there are Mitsubishi Chemical Industries, Ltd., Mitsubishi Petrochemical Co., Ltd., MGC, and etc. Each of these companies is an entirely independent organization, and each has its own characteristics in its field of business activities, manufacturing technologies and products.

MGC's products are summarized in the following four categories.

a. Methanol and ammonia manufactured by using natural gas (mostly from MGC's own well), and their derivatives

b. High purity, ortho-, meta-, para-xylenes and their derivatives.

c. Industrial chemicals such as hydrogen peroxide, sodium hydrosulfite.

d. Polycarbonate resin, xylene formaldehyde resins and other polymers.

MGC exports not only these products but also their manufacturing technologies to industrial countries of Europe and U.S.A. as well as developing countries.

MGC is the pioneer in Japan to utilize natural gas for the production of methanol by its own technology. The plant is located at Niigata, north-eastern part of Japan facing the Japan Sea.

Present production capacity of methanol is approximately 300,000 T/Y and this will be increased to 450,000 T/Y in 1974.

When the above expansion program is completed, daily consumption of natural gas will be approximately 1.8 million Nm^3. This will be the larges methanol production and natural gas consumption in Japan.

2. Reason for SCP Development Program Using Methanol

Four years ago, MGC started to develop SCP from methanol in order to supply low cost and stable protein source for compound feed which is largely dependent on importation. This SCP development is now one of the most important global theme solving protein shortage problem against increasing world population and animal protein demand.

When MGC first launched into this field, the study of SCP from normal-alkane had already been well developed. After having carried out a series of fundamental study on SCP from methane, methanol, ethanol and acetic acid, MGC decided to adopt methanol as a substrate for SCP production. The reasons are as follows:

a. Methanol is highly soluble in water.

b. A wide variety of hydrocarbons ranging from methane to naphtha can be used as feedstock of methanol.

c. No polycyclic aromatic compounds are contained in methanol.

d. Less oxygen is required than methane when methanol is used as substrate.

e. When SCP plant is constructed adjacent to methanol plant, utilities can be effectively utilized as a whole.

f. Very low cost methanol is available by extremely large scale plant.

The above points are very important in view of economics and safety of SCP. Therefore, methanol is more advantageous to other hydrocarbons as feedstock for SCP.

3. Course of Development of SCP from Methanol

It was in 1969 that MGC started research and development of SCP. Since that time MGC has continued its joint study with Fermentation Research Institute (hereinafter called FRI) of the Ministry of International Trade and Industry in certain area of SCP study.

These studies resulted in the application of a number of patents in respect to many new strains and cultivation techniques. Studies on SCP from methanol are being carried out in MGC's Niigata Laboratory. In this laboratory, eighteen continuous fermentaters having capacities in the range of 1 - 50 l have been installed. These fermenters are designed to control the supply of substrate and medium containing other nutrients and to adjust pH and temperature etc. automatically. In addition, two different types of stainless steel fermenter of m^3 order, and their annexed separators, dryers are also installed. Protein products can be produced continuously, and all the necessary data regarding cultivation are collected, and various kinds of samples for tests are obtained from these

equipment.

Based on these information, a large scale pilot plant to be completed in th middle of next year is under construction.

Once this pilot plant goes into operation, it will serve to obtain design information for commercial plant construction, samples for fish and animal feed test including confirmation of safety, and for developing industrial use.

4. Some Technical Information of SCP from Methanol

New isolates of yeasts which can be cultivated at considerably high temperature have been found by MGC. An example follows:

Cultivation temperature	40°C
Generation time	3.8 hrs.
Crude protein content	52%
Yield	0.39 g-dry cell/gr methanol

Table 1 Parameters of MGC Yeast A

An example of other ordinary yeasts follows:

Cultivation temperature	30°C
Generation time	3.5 hrs.
Crude protein content	61%
Yield	0.38 g-dry cell/gr methanol

Table 2 Parameters of MGC Yeast B

The above figures were obtained by using continuous fermenters. It is possible to increase crude protein content of the said high cultivation temperature isolates based on past experiences of our studies. Details of this study will be reported at a later date.

A typical example of pseudomonad which MGC has found follows:

Optimum cultivation temperature	38°C
Generation time	1.3 hrs.
Crude protein content	86.8%
Yield	0.46 g-dry cell/g-methanol

Table 3 Parameters of MGC Bacterium

Comparing the above yeasts and bacterium, unit cost of crude protein in the bacterium is considered to be more economical than that of yeasts. However, estimation of protein production costs, investment of commercial plant, details of MGC SCP manufacturing process and manufacturing conditions will be obtained when the large scale pilot plant under construction is completed, and after having collected operational information of continuous operation for certain period of time.

These information may be available under certain terms and conditions.

Generally disadvantage of bacteria over yeasts in manufacturing SCP is that separation of cells will be more costly because of the minute size. However, this problem has been solved as MGC has developed an easy

separation method using ordinary yeast separator (centrifugal) by simply adding MGC's unique prior concentration stage.

Fig. 1 shows a rough sketch of MGC SCP manufacturing process. Tower type fermenter is adopted in order to increase efficiency.

5. Feeding Trial and Safety Test

Judging from the *values shown in Table 4, 5 and 6 SCP from methanol is highly promising as a new source of protein supplement for fish and animal feed. However, the microorganism should be free from pathogenicity, and any mutation should not occur during long term operation. In addition, the protein product should be non-toxic to animals. In order to confirm this, inspection of the microorganism itself and animal test with the protein product including multi generation tests should be carried out.

At the same time strict check should be made to see that no toxic substance contaminates raw materials. MGC is now carefully carrying out various kinds of test mentioned above. The results of the tests may be published at an appropriate time.

* These values represent only one of the yeasts and bacteria strain respectively with which MGC is working. The analytical values could be changed as developments proceed.

6. Economics of Substrate and SCP

Up to present, normal-alkane, gas-oil, alcohols such as methanol and ethanol, etc., have been used as raw materials for SCP and the development

of each has been carried out. It is easy to compare the advantages of each substrate by yield, protein content, etc. However, final protein product cost will be highly dependent upon cost of raw materials, conditions of utilities and other conditions of the manufacturing plant. Therefore, SCP manufacturing process to be adopted by the country, which plans to commercialize SCP production, should be suitable to the conditions of the country concerned.

It is needless to say that the competitive protein product cannot be obtained unless an organization who wishes to commercialize the project selects an appropriate plant location.

However, as mentioned at the beginning of this presentation, methanol can be produced by using hydrocarbon sources which can be comparatively easy to obtain from any part of the world.

We, therefore, are firmly convinced that it is one of the best way to solve world wide protein shortage problem by adopting methanol as a substrate for SCP production, with the expectation of stable supply of low cost and high quality protein product.

As stated in this presentation, MGC process is still in the development stage. However, when studies based on a large scale pilot plant which is under construction are completed, we shall be able to explain characteristics of MGC's SCP manufacturing process which will surely contribute to solve world wide protein crisis.

Remarks:

Regarding to disclosure of any information not described in this paper, but included in the scope of joint research with FRI, prior consent of FRI is necessary according to the provisions of joint research agreement between FRI and MGC.

Therefore, any question must be made in writing. We will answer them in writing at a later date as much as possible.

Table 4

General Analysis of MGC Protein Products

	Yeast B	Bacterium
Moisture	5.3	2.6
Crude Protein (N x 6.25) on dry weight basis	90.2	86.8
Ash	7.4	7.1
Crude lipids *	7.9	8.3

* Ether extraction after HCl hydrolysis

Table 5

Amino Acid Content of MGC Protein Products,

Soybean Meal and Fish Meal

(g Amino Acid/100 g Dry Materials)

Amino Acid	Yeast-B	Bact.	Soybean Meal (cp 45%)	Fish Meal (cp 64%)
Isoleucine	2.60	3.29	2.50	2.38
Leucine	3.71	5.35	3.40	3.74
Phenylalanine	2.31	2.73	2.20	2.05
Thyrosine	2.00	2.10	1.40	1.75
Threonine	2.43	2.81	1.70	2.41
Tryptophan	0.76	1.30	0.60	1.31
Valine	2.65	4.09	2.40	2.77
Arginine	3.33	3.73	3.20	3.86
Histidine	1.08	1.26	1.10	1.52
Lysine	3.59	4.63	2.90	4.28
Cystine	1.04	0.40	0.70	0.46
Methionine	0.93	1.57	0.60	1.22
Total S-Acids	1.97	1.97	1.30	1.68

Table 6

The Digestibility of Crude Protein and Metabolizable Energy

Protein Source	Digest. Crude Protein %	Metab. Energy Kcal/g
Yeast-B	88	2.5 - 3.4
Bacterium	85	2.7 - 3.5
Soybean Meal	87	2.3
Fish Meal	85	3.1

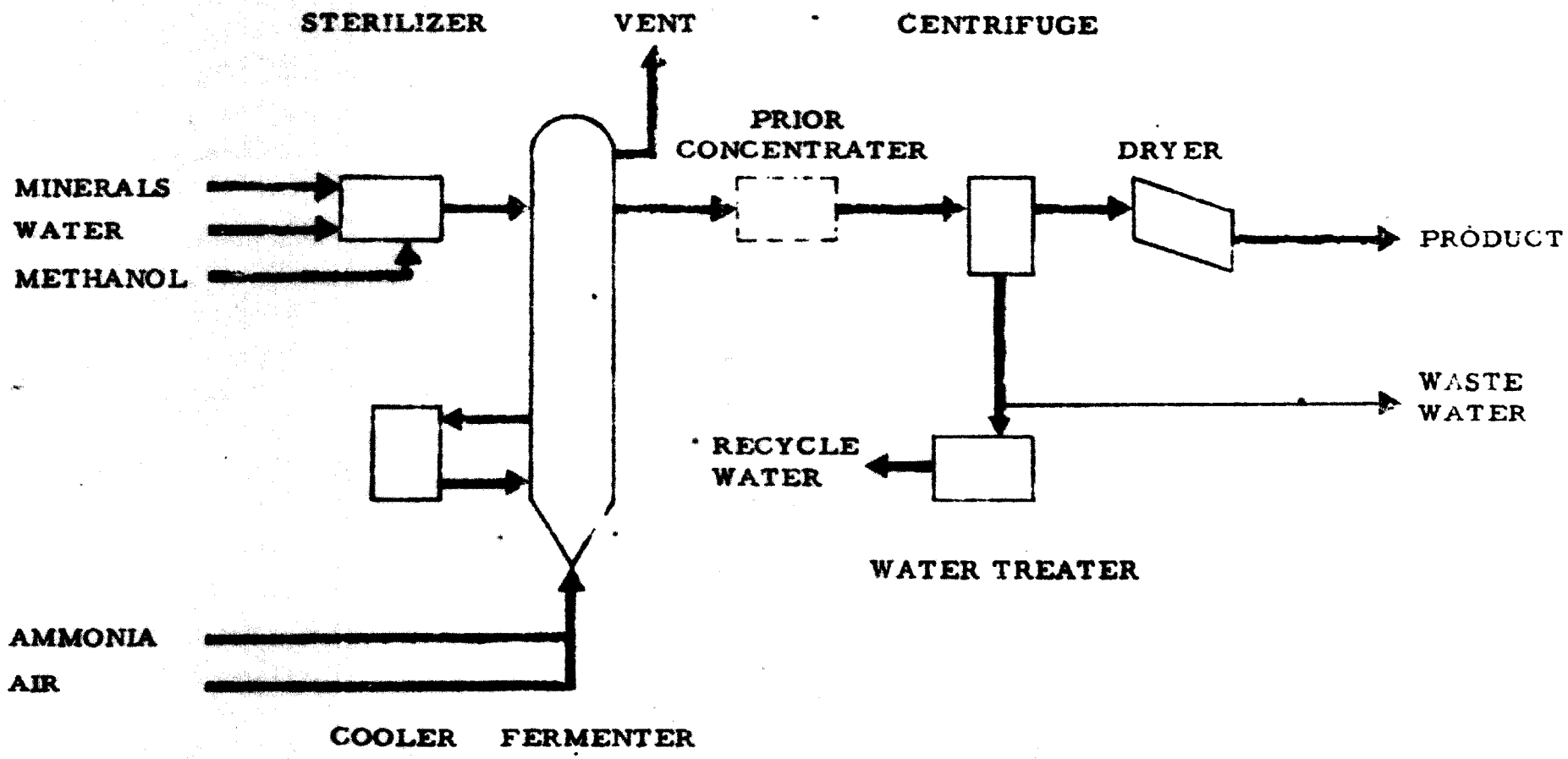
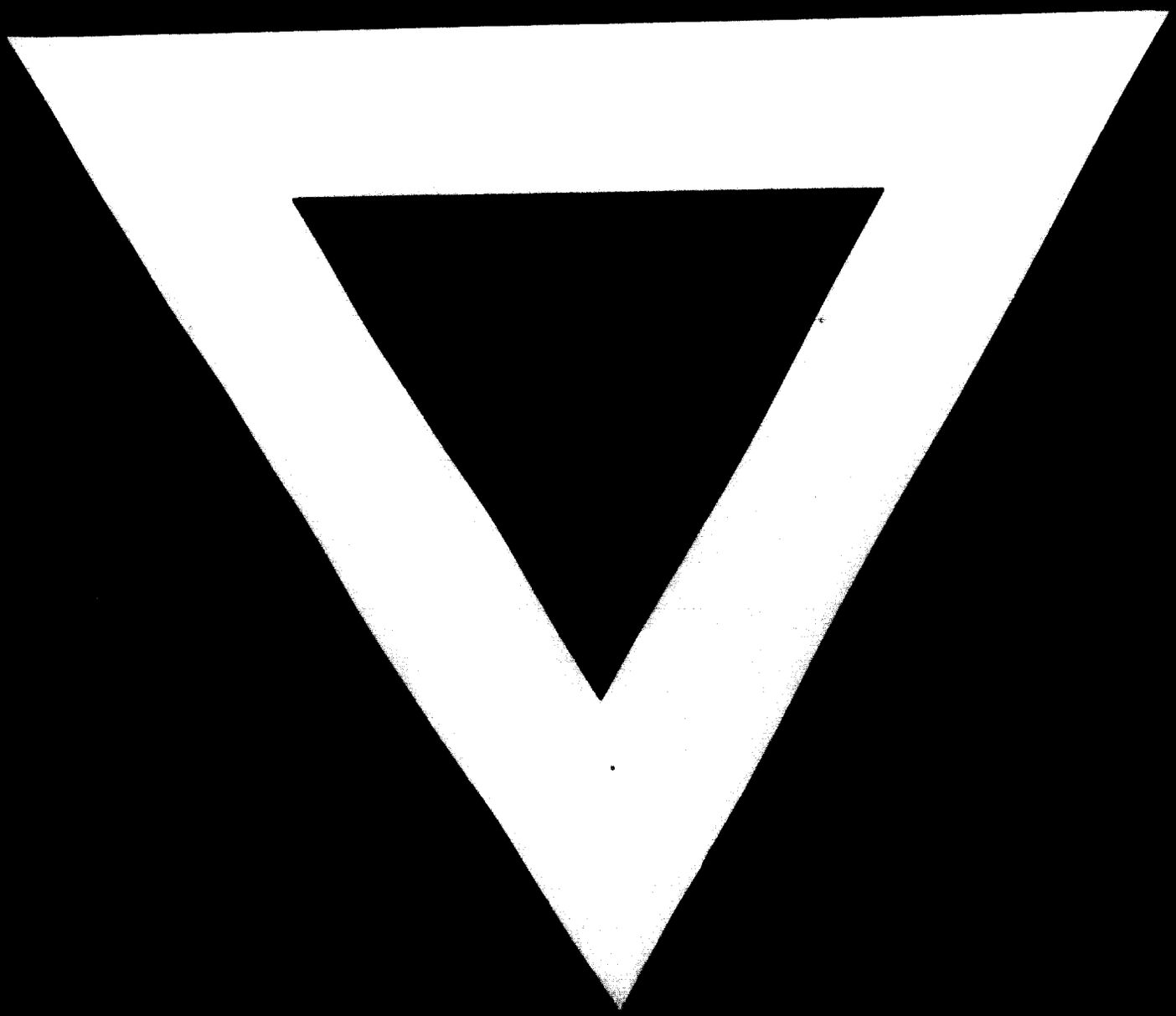


Fig. 1 MGC Methanol-SCP Process



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