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TOGETHER
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PROCESSES FOR THE PRODUCTION OF

PETROCHEMICAL POLYMERS

25

H. Hüfermann

H. K. Hauptner

W. Krönig

J. Körle

O. Peitz

presented by

H. Hüfermann

Farbenfabrik Bayer AG (Bayer)

Leverkusen

Federal Republic of Germany

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United Nations Industrial Development Organization

Regional Petrochemical Symposium on the
Development of the Petrochemical Industries
in Developing Countries

PET. SYMP. B/5

SUMMARY

PROCESS FOR THE PRODUCTION OF PETROCHEMICAL INTERMEDIATES 1/

by

H. Höfmann
H.K. Kemptner
W. Krönig
W. Kunze
O. Reitz

Farbenfabriken Bayer AG (Bayer)
Leverkusen
Federal Republic of Germany

Introduction

Of the many possibilities of converting basic petrochemical materials into intermediates, a group will be discussed here which has the following features in common:

- (a) the undermentioned simple aliphatic monoolefins serve as reactants:

ethylene
propylene
butene

- (b) these fumelins are converted with the aid of molecular oxygen

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1. The ethylene oxide direct oxidation process (further development)

Since described in "Chemie Rücksichten" improvements in the process giving better yields, longer life of the catalysts, etc.

The ethylene is oxidized with air in the gas phase on a stationary silver catalyst at 250 - 350°C and increased pressure in two stages. The starting product ethylene and air are fed into the cycle of the first stage and are convected with the recycle gas by means of a compressor to the parallel-connected outlet furnaces of the first stage. The heat of reaction is dissipated by the evaporation of water contained in the jacket system of the catalyst furnaces. The steam produced is utilized in the process. After appropriate cooling down, the furnace gas is passed on to a scrubber, where the ethylene oxide obtained is washed out with water. The gas free from ethylene oxide is replenished again with ethylene and air and is subjected again to the process just described. Part of the washed gas is passed to the catalyst furnace of the second stage, where furnace gas is also washed with water in a scrubber belonging to the second stage and is then passed into the atmosphere. The ethylene oxide formed is separated from the washing water, and the latter is again used for washing. The content of carbon dioxide and acetalddehyde in the ethylene oxide is reduced down to slight traces by fine distillation.

The production of one metric ton of ethylene oxide requires 1,720kg of ethylene; the investment for a plant for the production of 90,000 metric tons of ethylene oxide per year mounts to about 16.5 million US\$.

2. Oxidation of ethylene to acetalddehyde and of propylene to acetone

Also in these processes, molecular oxygen is added on to the olefinic double bond, but in this case not with the formation of an epoxide, but with the formation of an aldehyde or a ketone. The reaction is not carried out here - like in 1. - in heterogeneous catalysis in the gas phase, but the oxygen addition takes place with the aid of a redox system:

- (a) The olefins are oxidized by palladium salts (palladium chloride) in aqueous solution with reduction of the palladium chloride to metal.

- (b) The palladium met. I is again converted into palladium chloride by cupric chloride with reduction of the cupric chloride to the cuprous chloride.
- (c) The cuprous chloride is oxidized again by oxygen to the cupric chloride.

The reaction can be carried out either as a single stage or as a two stage process. In the first the ethylene and oxygen are passed into a vertical reactor containing the catalyst solution, regeneration of the catalyst taking place continuously. In the second, air is used to regenerate the catalyst in a separate reactor and the oxidation of ethylene carried out with air. In both cases the reaction takes place under moderate pressure and at 100°C which is sufficient to evaporate and concentrate the acetalddehyde which is then purified by a two-stage distillation.

The production of one metric ton of acetalddehyde requires 760 kg of ethylene (93.5% yield); the investment for a plant for the production of 70,000 metric tons of acetalddehyde per year amounts to about 4.0 million US\$.

OCTONE PROCESS

Propylene and catalyst solution are fed to a continuous reactor system in which virtually the entire propylene is converted in "one single throughput". The reaction takes place at a low pressure and about 100°C. After pressure reduction has taken place, the octane is stripped off from the catalyst solution. The latter is treated with air and recycled into the reactor system. The crude octane thus obtained is purified by means of a two-stage distillation. The air used for the oxidation is almost completely freed from oxygen.

The production of one metric ton of octane requires 700 kg of propylene (yield 91%); the investment for a plant for the production of 24,000 metric tons of octane per year amounts to about 3.5 million US\$.

The above mentioned processes of catalytic direct oxidation of olefins are applied in numerous large-scale plants all over the world. The aldehydes process has already reached the 2.5 thousand million lbs/year total capacity mark.

3. Addition of acetic acid on to ethylene by oxidative dehydrogenation to vinyl acetate

Till recently, vinyl acetate has been produced from acetylene and acetic acid. The recent trend to ethylene as a basic material has led to the development of a synthetic method based on ethylene, acetic acid and oxygen.

- (a) In the Kächet method, the palladium salt catalytic route is used by which acetaldehyde is obtained as a co-product.

Ethylene and oxygen are reacted at $12^{\circ} - 130^{\circ}\text{C}$ at a pressure of $30 - 40 \text{ kg/cm}^2$ in the presence of the catalyst dissolved in aqueous acetic acid. The molar ratio of acetaldehyde to vinyl acetate can be varied within a range from 1.3 to 2.5.

The production of one metric ton of vinyl acetate and a molar ration of acetaldehyde to vinyl acetate of 1.13 requires 845 kg of ethylene; the investment for a plant for the production of 75,000 metric tons of vinyl acetate per year and 3,000 metric tons of acetaldehyde per year (molar ratio acetaldehyde to vinyl acetate 1.13) amounts to about 7.10 million US\$.

- (b) In the Bayer method, ethylene and oxygen are recycled through a vapouriser in which they pick up acetic acid vapour. Fresh oxygen is added and the gaseous mixture passed at $140^{\circ} - 251^{\circ}\text{C}$ and $5 - 10 \text{ kg/cm}^2$ gauge over a metallic noble metal catalyst.

The plants according to the Bayer process in operation, under construction or in planning have a either a vinyl acetate capacity of more than a quarter million metric tons per year.

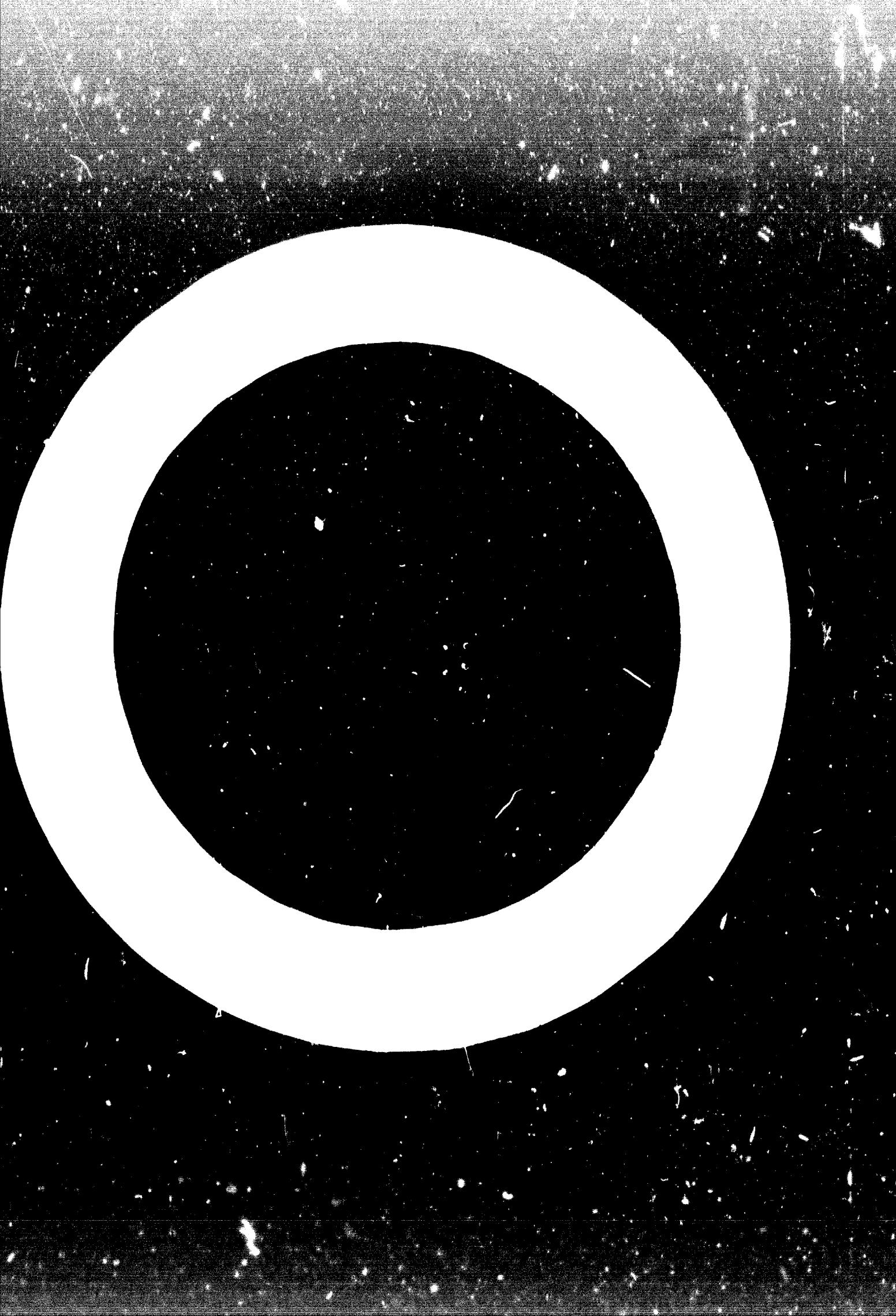
4. Oxidative splitting of n-butene to acetic acid

Difficulties in the oxidative splitting of n-butene to acetic acid due to the formation of by-products have been overcome by the preliminary formation of butyl acetate. Cracking then gives acetic acid.

Feedstock is the n-butene mixture (with butane), as it is received from the foregoing treatments. The conversion of the n-butene with pure acetic acid (first stage) is accomplished in the liquid phase at elevated temperature and pressure in the presence of a finely divided catalyst,

suspended in the reaction mixture and recycled in the system. The non-converted butene (20 - 50%) can - if so desired - be recycled via an extractive distillation. The butyl acetate in the acetic acid solution is oxidized (second stage) with air at elevated temperature and pressure in liquid phase with high recycle inside the system of the liquid reactor products through a heat exchanger. The energy of the residual gas is used for the compression of the air.

The production of one metric ton of acetic acid requires 800 kg of n-butene; the investment for a plant for the production of 60,000 metric tons of acetic acid per year amounts to about 10 million US\$.



- 1.0 Ethylene oxide direct oxidation process
- 2.0 Oxidation of ethylene to acetaldehyde and of propylene to acetone
 - 2.02 Reaction scheme
 - 2.10 Acetaldehyde process
 - 2.11 One-stage process
 - 2.111 Description of the process
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- 3.0 Addition of acetic acid on to ethylene by oxidative dehydrogenation to vinyl acetate
 - 3.01 Principle of vinyl acetate synthesis from ethylene
 - 3.10 Procedure with palladium salt / redox system in the liquid phase
 - 3.11 Description of the process
 - 3.20 Procedure in heterogeneous catalysis
 - 3.21 Description of the process
 - 3.23 Technical plants
- 4.0 Oxidative splitting of n-butene to acetic acid
 - 4.01 Fundamentals
 - 4.02 Description of the process

Introduction:

Of the many possibilities of converting basic petrochemical materials into intermediates, a group will be discussed here which has the following feature in common:

- a) the under-mentioned simple aliphatic monoolefins serve as feedstocks:

ethylene

propylene

n-butene

- b) these feedstocks are converted with the aid of molecular oxygen.

The examples mentioned here show at the same time the versatility in the designing of the chemical action when the basic materials are converted into intermediates.

The following subjects will be dealt with more specifically:

-4-

1.0 Addition of oxygen to ethylene to form ethylene oxide

The traditional production of ethylene oxide was a typically chemical method of operation: Hypochlorous acid - produced from chlorine and water - was added on to ethylene to form ethylene chlorohydrin, which was then reacted with a base - for example lime - to ethylene oxide and calcium chloride.

It was a great step when this method of operation of classical chemistry was replaced by the petrochemical method of direct addition of molecular oxygen on to the double bond of ethylene in heterogeneous catalysis, ethylene oxide being formed. Hils reported on this at the 1964 Petrochemistry Meeting.

It has now generally been found that the petrochemical processes can still be considerably improved. Thus, also the process of Hils has been much improved during these five years, and Hils now submitted a report on the present state.

Addition of oxygen to ethylene to form acetaldehyde, and to propylene to form acetone

Also in these processes, molecular oxygen is added on to the olefinic double bond, but in this case not with the formation of an epoxide, but with the formation of an aldehyde or a ketone. The reaction is not carried out here - like in 1.0 - in heterogeneous catalysis in the gas phase, but the oxygen addition takes place with the aid of a redox system.

2.1 Conversion of ethylene into acetaldehyde

This process was already briefly reported on by Hoechst during the previous UNIDO Petrochemistry Conference. It appears advisable now to give a survey of the present state of the process.

2.2 Conversion of propylene into acetone

Transferring the method of operation of the acetaldehyde process to propylene as a feedstock leads to the formation of acetone. As this process too has in the meantime gained some commercial importance, it appears advisable to give a report on it.

3.0 Addition of oxygen added to ethylene in oxidative dehydrogenation to vinyl acetate

In the processes considered so far (1.0 and 1.2), the molecular oxygen is added to the olefine with elimination of the double bond. In the process to be considered now, the oxygen does not attach to the olefine, but it carries oxidizing dehydrogenation with formation of water, so that the unsaturated ester vinyl acetate is obtained, with the double bond being maintained.

Two methods of operation will be considered here:

3.1 In the process of Hoechst, the conversion takes place, like in the acetaldehyde process, with the aid of a redox system; besides vinyl acetate, also acetaldehyde is obtained;

3.2 in the process of Bayer, the oxidizing dehydrogenation is carried

out in heterogeneous catalysis; the mechanism is being formed.

Reaction Mechanism

The reaction mechanism is a complex process involving several steps. It begins with the adsorption of the reactants onto the catalyst surface. This is followed by the formation of an intermediate species, which then undergoes further transformation. The final step involves the desorption of the products from the catalyst surface. The overall mechanism is highly dependent on the specific catalyst used and the reaction conditions.

Catalyst Properties

1.1.1. Catalyst Properties

There are several key properties that are important for a catalyst to be effective. These include:

- High surface area:** A large surface area provides more sites for the reactants to adsorb and react.
- Stability:** The catalyst must be stable under the reaction conditions, both thermodynamically and kinetically.
- Selectivity:** The catalyst should selectively catalyze the desired reaction, avoiding side reactions.
- Activity:** The catalyst should have a high rate of reaction.

In addition to these general properties, specific catalysts may have unique properties that are tailored to a particular reaction.

Overall, catalyst properties are critical for the success of a reaction, and their selection and optimization is a key aspect of catalytic research.

[REDACTED]

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QUESTION: In which processes the working fluid is either air or pure oxygen?

In view of the fact that there has been no change
in the composition of the city council, there has been no change
in the composition of the city council, and the new members are appointed by the city-

10. 1. 1990. 10. 1. 1990. 10. 1. 1990. 10. 1. 1990. 10. 1. 1990. 10. 1. 1990.

19. *Leucosia* *leucostoma* (Fabricius) *Leucosia* *leucostoma* (Fabricius) *Leucosia* *leucostoma* (Fabricius) *Leucosia* *leucostoma* (Fabricius)

10. The following table shows the number of hours worked by 1000 employees in a company.

在這裏，我們將會看到一個簡單的範例，說明如何在一個應用程式中使用這些技術。

...and the first step in this direction is to have the Governor,

（三）在本屆全國人民代表大會上，我們要進一步加強和改善党的领导，把全民族的智慧和力量集中起來，為完成黨和人民賦予的歷史任務而奮鬥。

ANSWER The answer is **none of the above**.

100% of the time, the system was able to correctly identify the target word.

在於此處，我們將會看到一個簡單的範例，說明如何在一個單元中，將一個或幾個子單元的執行結果，傳回給主單元。這就是所謂的 **return** 語句。

186
The following table gives the results of the experiments.

The following is a brief history of the first year of the school, now known as the Alton

$\beta = \text{diag}(\alpha_1, \alpha_2, \dots, \alpha_n)$, $\alpha_i \in \mathbb{R}$, $i = 1, 2, \dots, n$

by-product carbon dioxide is highly exothermal. The heat of reaction is dissipated by the evaporation of water contained in the jacket space of the radiant furnace. The steam produced is utilized in the process. After appropriate cooling, the furnace gas is passed into a scrubber, where the ethylene oxide obtained is washed out with water. The gas free from ethylene oxide is replenished with air, the air and air are subjected again to the process purification. Part of the washed gas is turned to the catalyst furnace at the "Buchen" stage whose furnace gas is then washed with water, the water which, owing to its speed, is caused to then pass through a separator here. The ethylene oxide formed is separated from the wash water, and the latter is again for washing. The water is washed twice and finally in the stayline and then dried in the light traps by fine distillation.

a) Consumption Figures

a) Raw material consumption per metric ton of ethylene oxide

ethylene (1.5 kg/cm² absolute)

1020 kg

Air (6 kg/cm² absolute) 7000 m³

at S.T.P.

b) Utility consumption

per 1 metric ton of ethylene oxide

cooling water (20° C) 360 m³

cold water (+ 5° C entry)

13 m³

(+15° C exit)

| | |
|--|-------------------|
| power (500 v) | 150 kwh |
| power (6 kv) | 500 kwh |
| deionized water | 12 m ³ |
| steam (20 kg/cm ² absolute) | 4.9 tons |
| steam (4 kg/cm ² absolute) | 0.4 ton |

Credit:

| | |
|--|----------|
| steam (50 kg/cm ² absolute) | 8 tons |
| steam condensate | 5.3 tons |

c) Investment

for a 20,000 metric ton per year plant about 10.5 million US (in the Federal Republic of Germany) battery limits (without store for starting and finished products, first catalyst filling, engineering, financing, site development, lines up to the battery limits)

d) Personnel required

5 - 6 workmen per shift

1.04 Literature

Publication in the supplement volume of Ullmann is being prepared.

2.0 Oxidation of ethylene to acetaldehyde and of propylene to acetone

2.01 Fundamentals

At the 1964 UNIDO Petrochemical Meeting, Hoechst reported on the production of acetaldehyde by oxidation of ethylene. The reaction dealt with at that

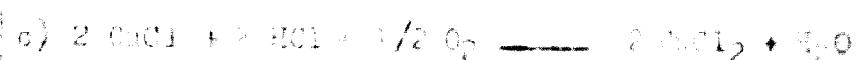
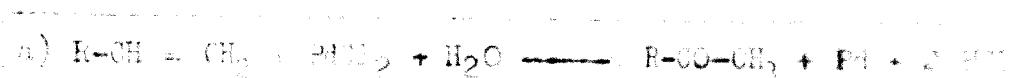
- 14 -

time is not restricted to the oxidation of ethylene, but can be applied more generally. Beside the oxidation of ethylene to acetyl chloride (2.1), also the oxidation of propylene to acetone (2.2) will therefore be dealt with here.

The reaction principle is the use of a redox system:

- The olefin is oxidized by palladium oxide (palladium chloride) in aqueous solution with reduction of the palladium chloride to the metal.
- The palladium metal is converted again by means of copper chloride into palladium chloride with reduction of the cupric chloride to cuprous chloride.
- The cuprous chloride is oxidized again by oxygen to form cupric chloride.

These three stages, supplemented by the summary d), are shown by the following scheme:



$R = H, C_2H_5, C_3H_7$

2.02 Reaction scheme of olefin oxidation to alkylic acid chloride

• *Other features of the platform will be added later in a "stable tree".*

卷之三

• 11

如上所述，本研究在对不同年龄阶段的被试进行实验时，发现年龄越小的被试，其对“我”的识别率越高。

卷之三

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卷之三

在這裏，我們將會看到一個簡單的範例，說明如何使用 `PyTorch` 來訓練一個卷積神經網絡。

¹ See also the discussion of the relationship between the two concepts in the section on "The Concept of Social Capital."

在這裏，我們將會看到一個簡單的範例，說明如何使用 `PyTorch` 在 GPU 上訓練一個卷積神經網絡。

10. The following table gives the number of hours worked by 1000 workers in a certain industry.

1. The first step is to identify the specific needs of the organization and its stakeholders.

For more information about the study, please contact Dr. Michael J. Hwang at (310) 206-6500 or via email at mhwang@ucla.edu.

在本研究中，我们探讨了不同类型的土壤污染对小麦生长的影响，并提出了相应的管理建议。

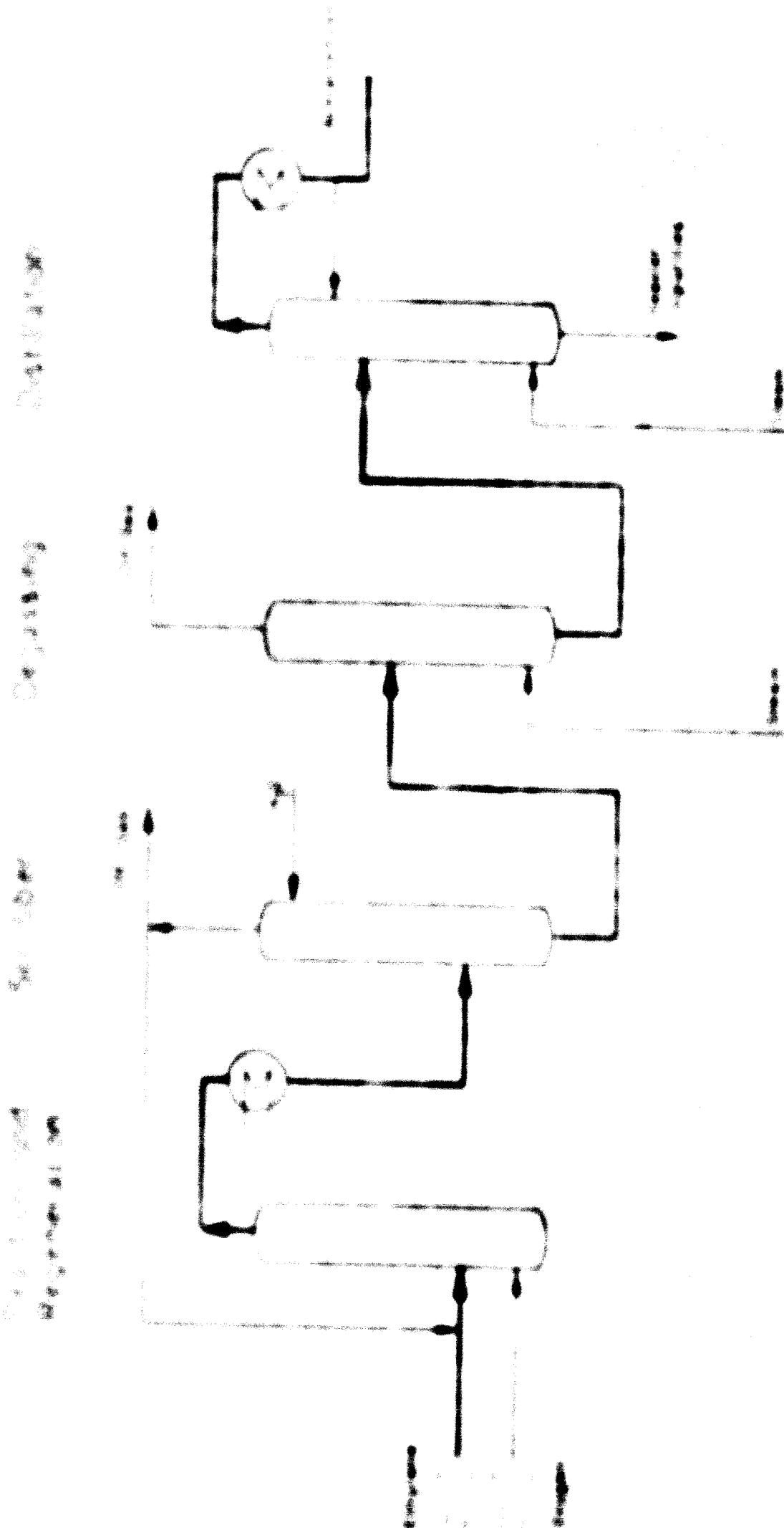
新編 金言 卷之三

在本研究中，我们探讨了不同类型的音乐对情绪状态的影响。

10. The following table summarizes the results of the study. The first column lists the variables, the second column lists the sample size, and the third column lists the estimated effect sizes.

ACETALDEHYDE PRODUCTION CYCLE STAGE 1

2000



2. 12 一九一九年五月廿四日

THE PROCESS

The catalyst solution are passed through a continuously operating reactor in which virtually the entire ethylene is converted to acetaldehyde throughout. The reaction takes place under varied conditions throughout. The first of reaction obtained was at 100° C. and 1000 psi. The first of reaction obtained was at 100° C. and 1000 psi. The first of reaction obtained was at 100° C. and 1000 psi. The first of reaction obtained was at 100° C. and 1000 psi. The first of reaction obtained was at 100° C. and 1000 psi.

After the first separation, the product was taken to a second reactor by air and further reduced to 10% solids by adding water to the first reactor. The final product was then separated from the water in the first reactor.

The first solution is almost completely decolorized by the addition of 10% of the bright solution. The second solution is also decolorized by the addition of 10% of the bright solution. The third solution is almost completely decolorized by the addition of 10% of the bright solution.

the first identical with
the second, which is very similar to the first, and the third identical with
the second, which is very similar to the first, also

Journal of Clinical Endocrinology and Metabolism, Vol. 103, No. 3, March 1994, pp. 723-728.

...and the other two species are also related to the eucalyptus wood.

When raw and auxiliary materials according to the following specification are used for the production of one metric ton of acetaldehyde (99.5%) the average consumption for the one-stage and the two-stage process is:

| | <u>One-stage
process</u> | <u>Two-stage
process</u> |
|-------------------------|-------------------------------|-------------------------------|
| a) <u>Raw materials</u> | | |
| Ethylene (100%) | 670 kg | 670 kg |
| Oxygen (100%) | 280 m ³ at 1.17 P. | |
| Air | - | 1600 m ³ at S.P.F. |
| Sulfuric acid (31%) | 15 kg | 40 kg |
| Chlorine | approx. 1.45 kg | 1.45 kg |
| Hydrogen | 0.85 m ³ | - |
| b) <u>Electricity</u> | | |
| Electrolysis (100%) | 20 m ³ | 40 m ³ |
| Incineration (120%) | 7 m ³ | 10 m ³ |
| Steam | 1200 kg | 1000 kg |
| Electric | 10 kWh | 10 kWh |

c) Estimated labour (both one-stage and two-stage processes)

1 man day

1 for the

1 laboratory assistant

4 workers per shift

d) Investment

For a plant for the production of 100,000 metric tons per year

2.102

of acetaldehyde, the investment, based on Federal Republic of Germany, is about 4.0 million US\$. The investment comprises the overall performances inside battery limits. This account includes in the case of the one-stage process the oxygen plant and in the case of the two-stage process the air compressors.

2.103 Technical hints

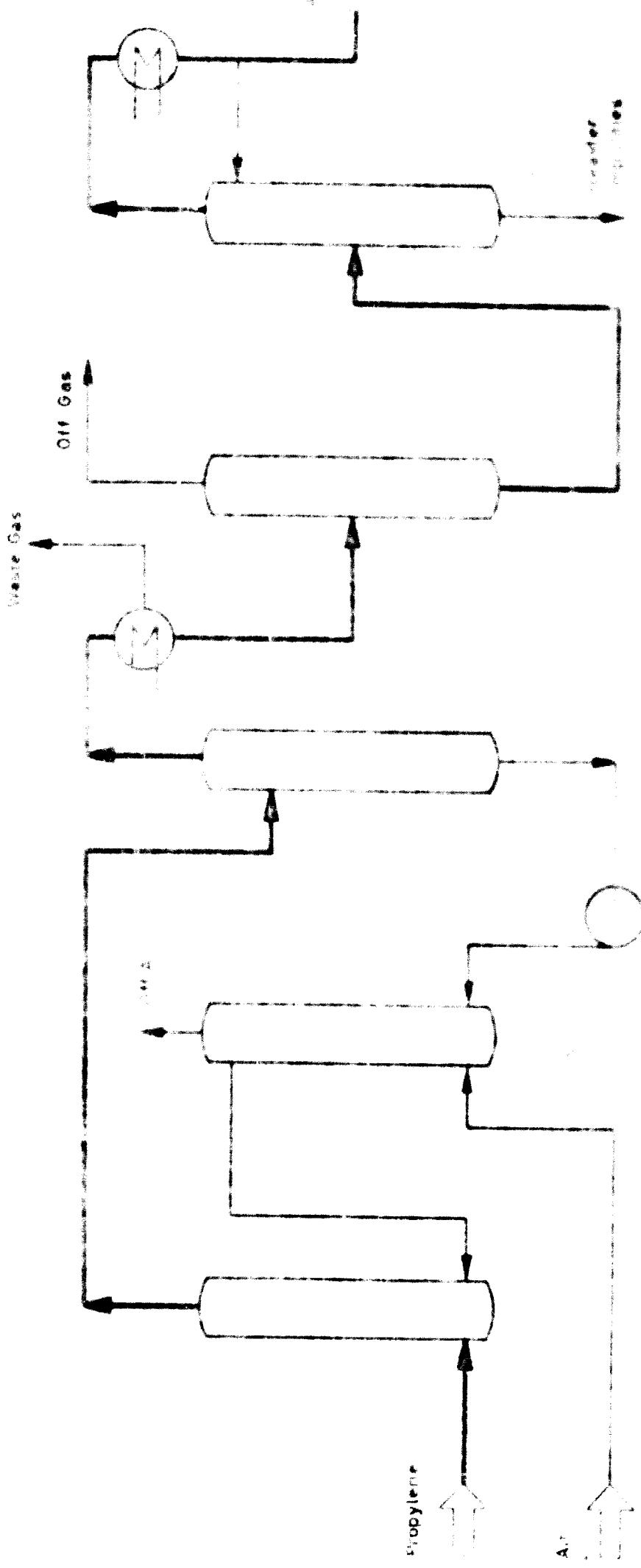
2.104 A number of improvements of the various operational steps have been made since 1959, when the first aldehyde plant by the process was built oxidation of ethylene over an alumina. While in 1960 the capacity per reactor was 24,000 metric tons per year of acetone, it rose in 1973 to 60,000 metric tons per year, and in 1980 to two units with 30,000 metric tons per year of acetaldehyde. Capacity and capacity per reactor unit of 100,000 metric tons of propionaldehyde are being planned.

2.20 Acetone synthesis

2.21 Details of the process (See Scheme 2.21)

Propylene and catalyst solution are fed to a continuous reactor system without splitting the entire propylene is converted in "one-pot" synthesis". The reaction takes place at a low pressure of about 100 hPa. The reaction is exothermal and its heat effect is 61 kcal per mol of acetone produced. After pressure reduction has taken place, the acetone is stripped off from the catalyst solution. The latter is treated with air and recycled into the reactor system. The crude acetone thus obtained is purified.

Reaction Degassing Separation
Regeneration Degassing Separation



卷之三

1. *Leucosia* *leucostoma* *leucostoma* *leucostoma*

卷之三十一

Figure 1. The effect of the number of nodes on the performance of the proposed algorithm.

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1960-1961

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新嘉坡之行，是次回國之始，吾人當盡其樂也。

“*It is the first time I have ever seen a man who has been to the moon*,” he said.

在《新約全書》中，耶穌說：「我就是道路、真理、生命。」¹ 耶穎基爾說：「我就是那生命的水。」² 在《舊約全書》中，耶和華說：「我是生命的水。」³

卷之三

10. *Uttarāvadī* उत्तरावदी. उत्तरावदी एवं उत्तरावदीया दोनों शब्दानि असमीकृत शब्द हैं।

²⁰ See also the discussion of the relationship between the concept of "cultural capital" and the concept of "cultural value" in the section "Cultural Capital and Cultural Value."

卷之三十一

（三）在本办法施行前，已经完成登记的个体工商户，可以向登记机关申请换发加载统一社会信用代码的营业执照。

10. The following table shows the number of hours worked by each employee in a company.

卷之三

Exercise 2

1. What is the difference between a primary and a secondary market?

A primary market is where new shares are issued by a company to raise capital. A secondary market is where existing shares are traded between investors.

2. What is the difference between a stock exchange and a over-the-counter market?

A stock exchange is a formal market where stocks are listed and traded on a designated exchange floor. An over-the-counter market is a less formal market where stocks are traded through a network of brokers and dealers.

3. What is the difference between a cash market and a derivatives market?

A cash market is where physical goods or financial instruments are bought and sold for immediate delivery. A derivatives market is where contracts are traded that represent an asset or obligation, such as futures or options.

4. What is the difference between a spot market and a forward market?

A spot market is where goods or financial instruments are bought and sold for immediate delivery. A forward market is where contracts are traded for delivery at a future date.

5. What is the difference between a primary and a secondary market?

A primary market is where new shares are issued by a company to raise capital. A secondary market is where existing shares are traded between investors.

6. What is the difference between a stock exchange and a over-the-counter market?

A stock exchange is a formal market where stocks are listed and traded on a designated exchange floor. An over-the-counter market is a less formal market where stocks are traded through a network of brokers and dealers.

7. What is the difference between a cash market and a derivatives market?

A cash market is where physical goods or financial instruments are bought and sold for immediate delivery. A derivatives market is where contracts are traded that represent an asset or obligation, such as futures or options.

8. What is the difference between a spot market and a forward market?

A spot market is where goods or financial instruments are bought and sold for immediate delivery. A forward market is where contracts are traded for delivery at a future date.

In the case of the granular catalyst (layer), the process is carried out, with the same probabilities. However, obtained, as a heterogeneous catalyst, which is a granular catalyst, preferably in the gas

10. What is the name of the liquid

3.11) *Explain the concept of a vector space.*

Specimens were collected from the coastal thalassophytic marshes in which the

Reaction

Temperature

What is the effect of reaction conditions on the reaction?

As a result of the above findings, it is recommended that the following changes be made in the current carbon monoxide

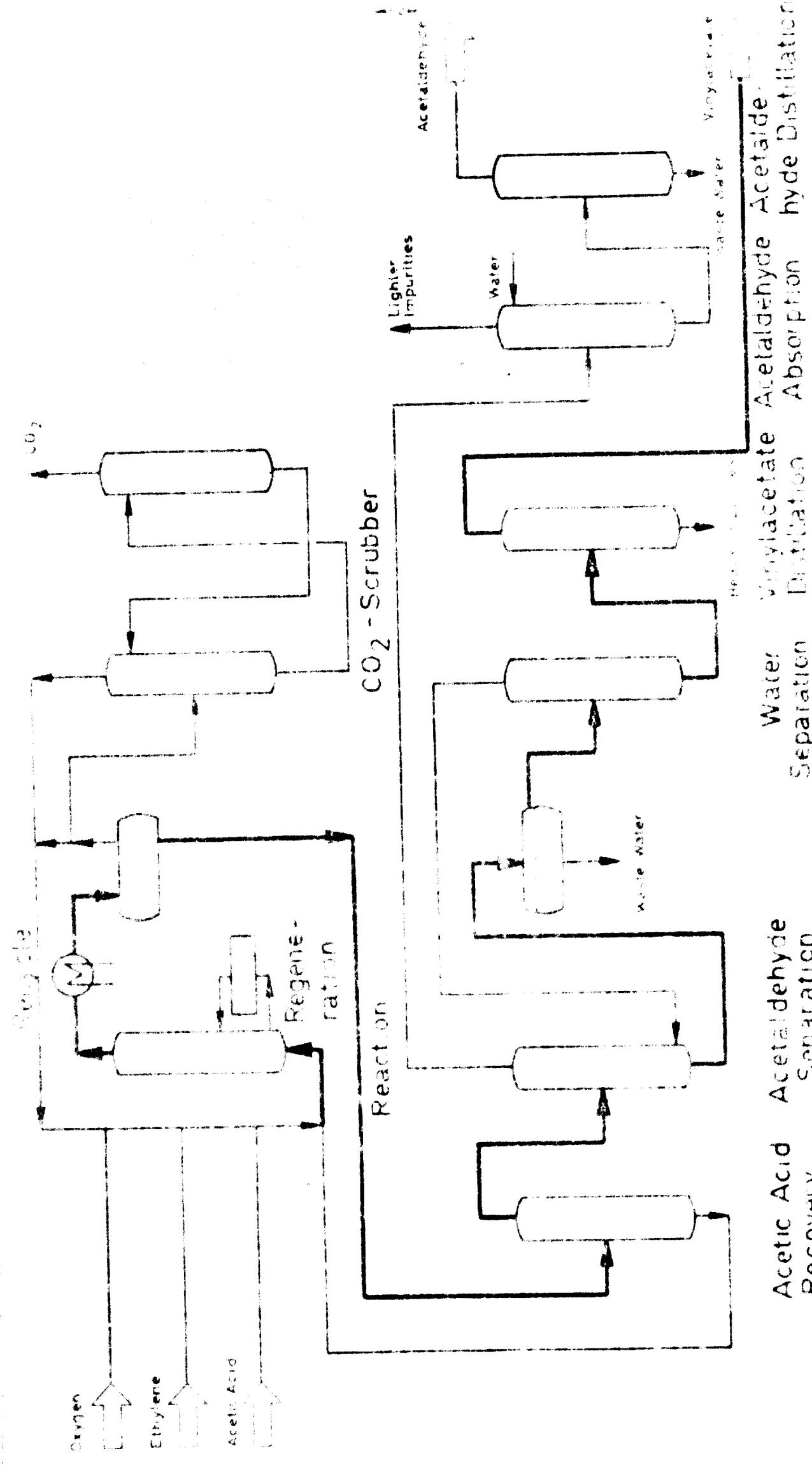
10.0 g of the product was dissolved in 10 ml of water and titrated with 0.1 N sulfuric acid.

*Specimens of the genus *Leucostoma* have been collected from the following localities:—*

20. *Scutellaria* *lanceolata* L. - *Lanceolate skullcap*

The film thickness was measured by a profilometer (Dektak 150) and a
surface roughness value of 1.13 nm was obtained.

卷之三



Acetic Acid Recovery
Acetaldehyde Separation
Acetone Recovery

Water Separation

Vinyl acetate Distillation
Acetaldehyde Absorption
Hyde Distillation

a) Raw materials:

| | |
|---------------------|----------|
| Ethylene (100 %) | 845 kg |
| Oxygen (100 %) | 760 kg |
| Crystalline acetone | 3.75 USG |

b) Utilities:

| | |
|---------------------|--------------------|
| Cooling water | 593 m ³ |
| Low-pressure steam | 2.62 tons |
| High-pressure steam | 2.90 tons |
| Power | 315 kw |

c) Personnel required:

- 1 Chemist
- 1 Operator
- 6 Workmen per shift

The above data include already the consumption figure for the auxiliary feed plants.

d) Investment:

The investment for the erection of a plant for the production of 7500 metric tons per year of vinyl acetate with simultaneous production of 43,000 metric tons per year of acetaldehyde (molar ratio acetaldehyde to vinyl acetate 1.12) is 7.18 million US\$ based on the Federal Republic of Germany. This amount includes all expenditure for machinery and plant including assembly inside factory limits. The acetaldehyde produced as a co-product in a molar ratio of 1.13 is oxidized to form acetic acid. The

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1996-03-20 10:00:00 1996-03-20 10:00:00

Figure 1. A schematic diagram of the experimental setup. The light source (laser) emits a beam that passes through a lens and a polarizer. The beam is focused onto a sample stage, which holds a sample and a reference mirror. The reflected light from the sample and the reference mirror is collected by a lens and focused onto a photodetector.

19. *Leucosia* *leucostoma* (Fabricius) *leucostoma* (Fabricius) *leucostoma* (Fabricius)

三

19. A. *Leucosia* sp. (Diptera: Syrphidae) was collected from a small stream in the northern part of the study area.

Fig. 1. A photograph of the same area as Fig. 1, but taken at a later date. The vegetation has been cleared and the ground is bare.

19. The following is a list of the names of the members of the Board of Directors of the Company.

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For more information about the study, contact Dr. Michael J. Hwang at (319) 356-4000 or email at mhwang@uiowa.edu.

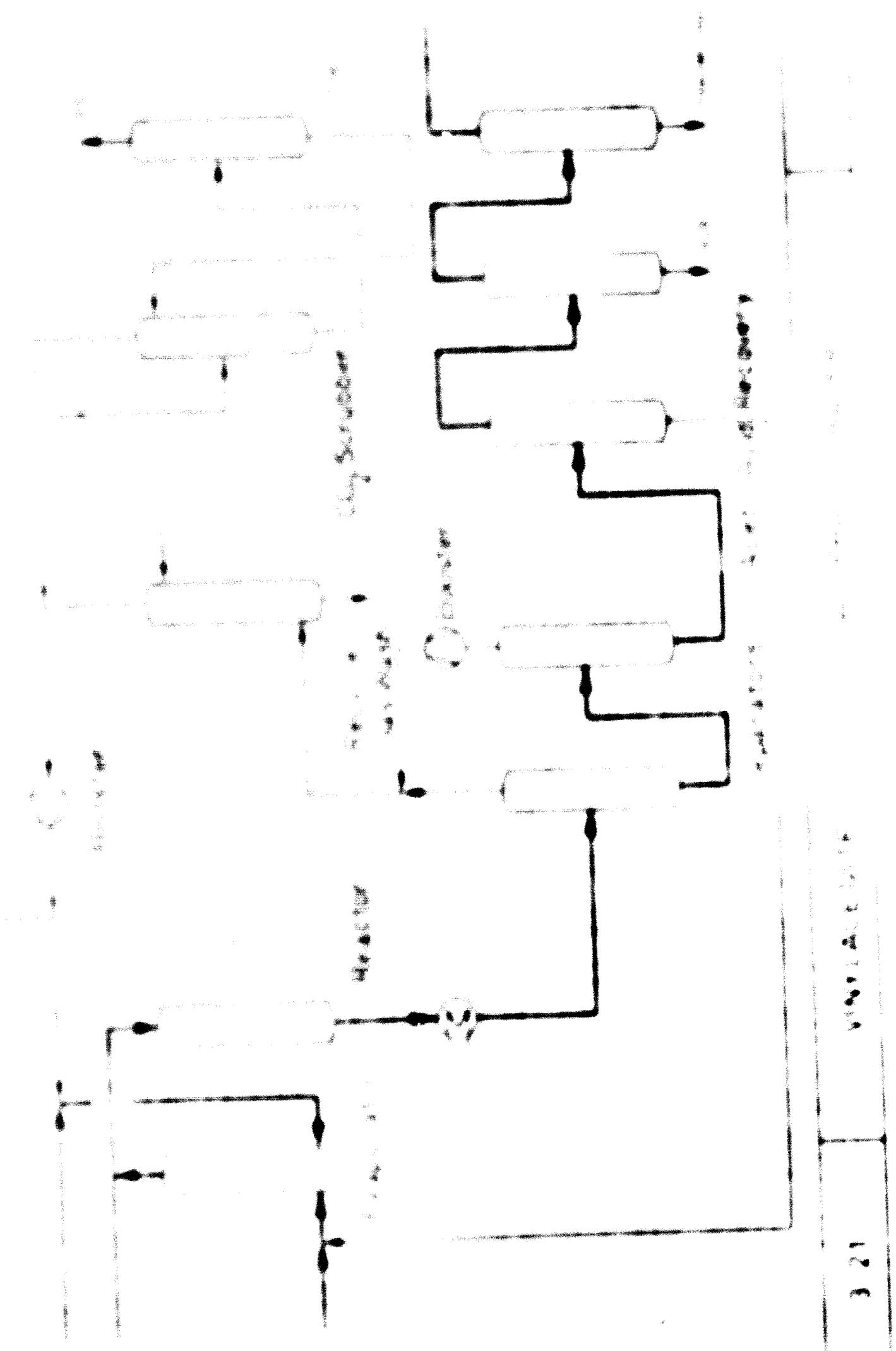
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在《新編中華書局影印本》中，「新編」二字被省略，只標「中華書局影印本」。

10. The following is a list of the names of the members of the Board of Directors of the Company.

...and the other side of the coin is that the same people who are most likely to be successful in business are also most likely to be successful in life.

For more information about the study, please contact Dr. Michael J. Coughlin at (319) 356-4000 or via email at mcoughlin@uiowa.edu.



The valley is very narrow and deep, and the water is very rapid.

...and the first license was issued on this date. The first license was issued to a Mr. George W. Hargrove, who had been granted a license to operate a
gasoline station at the corner of Main Street and Main Street. This license was later
renewed for several years.

... will come in early 1971.

Geological Proc., 7th Ind. Petr. Congr., Vol. 5, 41/42 (1967)

10. *Leucosia* *leucostoma* (Fabricius) (Fig. 10)

Chem.-Phys.-Festnahmetechnik 12, 5-16, 1968/1969 (1968)

Journal of Legal History and Intensity (1958), 159/1593

REVIEW OF THE PREPARATION OF BUTANE

2. Experiments on the Preparation of Butane

The first step in the preparation of butane is the separation of butane from the vapors of the hydrocarbons which are present in the overhead from the distillation column. This separation may be accomplished by absorption of the overhead in a liquid solvent or by condensation of the overhead in a cold trap. The overhead may consist of a mixture of butane, propane, ethane, and acetylene. If the overhead contains a large amount of acetylene, it is possible to remove the acetylene by absorption in a liquid solvent such as benzene. If the overhead contains a small amount of acetylene, it is possible to remove the acetylene by condensation in a cold trap. The following experiments will illustrate methods for separating butane.

1. Separation of Butane by Absorption in Benzene.

In a separatory funnel containing 100 ml. benzene, add 10 ml. of concentrated sulfuric acid. Add 10 ml. of concentrated hydrochloric acid. Add 10 ml. of concentrated nitric acid. Add 10 ml. of concentrated phosphoric acid. Add 10 ml. of concentrated acetic acid.

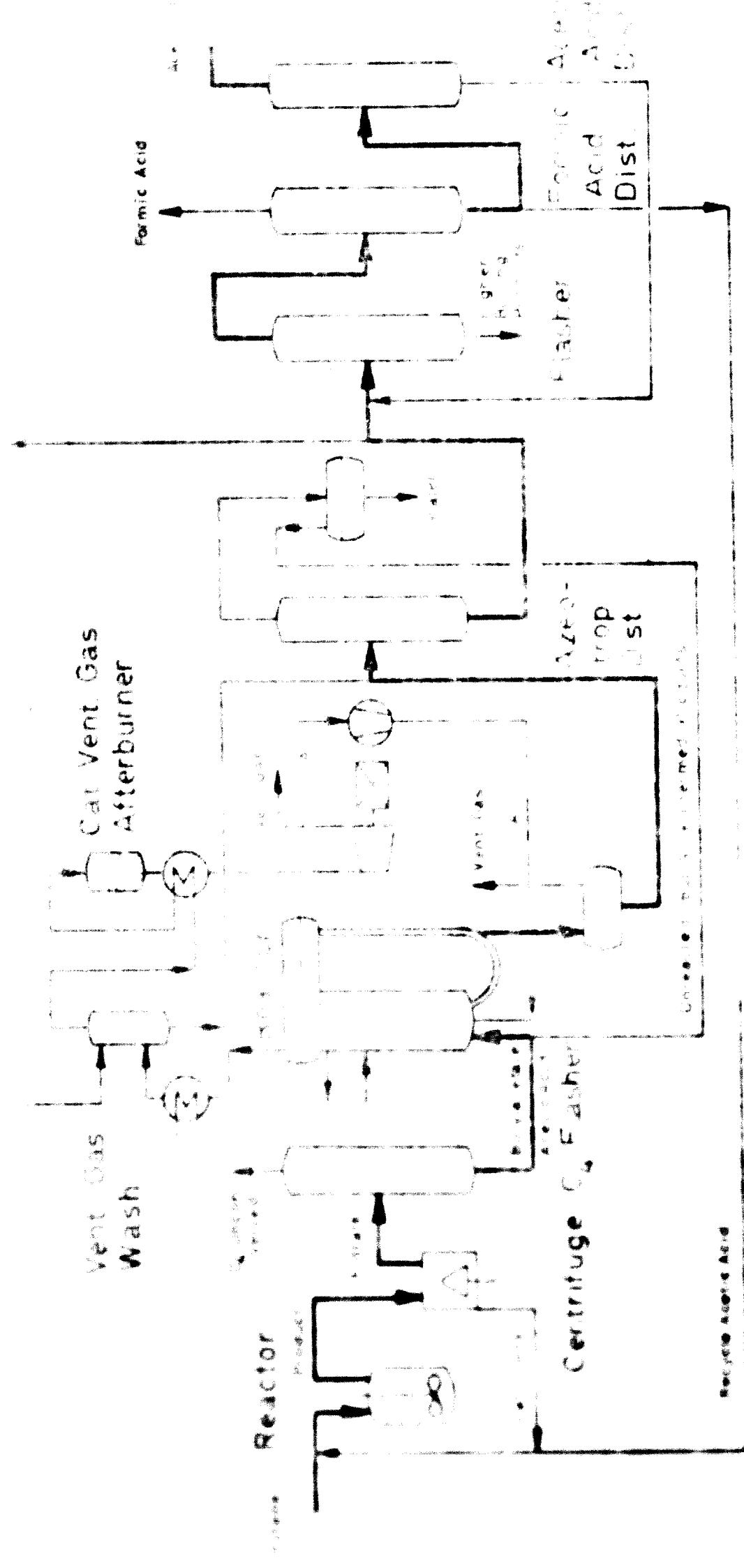
(1 mole) (1 mole) (1 mole) (1 mole) (1 mole)

_____ (1 mole) (1 mole)

4.01. Preparation of concentrated sulfuric acid.

A. 02. Preparation of concentrated hydrochloric acid.

Benzene is a colorless mixture (with butane), as it is received from Bechtel, and is colorless. The separation of the benzene with surplus butane is accomplished by the addition of benzene with surplus acetylene and (first stage) is accomplished in the liquid phase at elevated temperature and pressure in the presence of a finely divided catalyst, a



suspended in the reaction mixture and recycled in the system. The non-converted butene (20-50%) can - if so desired - be recycled via an extractive distillation. The butyl acetate in the acetic acid solution is oxidized (over cobalt) with air at elevated temperature and pressure in liquid phase with high recycle inside the system of the liquid reaction products through a heat exchanger. The energy of the residual gas is used for the compression of the air.

The recovery of the pure acetic acid from the liquid oxidation products is difficult, as, during the acidification and neutral distillation; it is possible - if wanted - to recover also the intermediate: sec. butyl acetate.

四、五、六、七、八、九、十、十一、十二、十三

The final products for the organic acid production by this process are as follows:

| | I | II |
|---------------------------------------|----------------|---|
| Kerosene (petroleum oil) | 110 | 195 |
| Fuel oil (petroleum) | 280 | 850 |
| Electric power (kwh) | Unit | per 1 metric ton of
electricity produced |
| Gasoline (petroleum) | kg | 800 |
| Power | kwh | 670 |
| Cooking gas (kg) | m ³ | 156 |
| Propane (kg) | kg | 1,350 |
| Lubricating oil (kg) (petroleum base) | kg | 1,280 |

| | | |
|---------------------------------|--------|--------|
| Acetic acid production m.t./yr | 25,000 | 60,000 |
| Capital investment million US\$ | 6.125 | 10.0 |

1. Acetone

Chem. Eng., 14th Ann. Petr. Congr. I., 1966 (1967)

Chem. & Ind. (London), 140/148 (1968)

2. POLYBUTENE

The polymerization of n-butene available are rather small so it is advantageous to have a process for converting the n-butene to acetic acid (Acetic acid) for which often a rather large amount.

3. OLEFINS

Appropriate methods of protective conversion of basic materials should be used. The simple removal of oxygen by gaseous nitrogen or helium may be too slow or too broad with of variations in polymerization reactions. The introduction of these methods of protection against cold oxidation has to bear rich fruit.

1. 2. 3. 4.





25. I. 72