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TRENDS IN THE INTERNATIONAL CHEMICAL INDUSTRY

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Feb 28, 1939.

I think it was rather unfortunate that I chose this subject now that I have had time to consider all of the complications and difficulties that I have gotten myself into. Really the subject is so intricate because it is so interwoven with politics that I am in somewhat grave doubt of being able to tell you a consecutive story that will not appear more like a patchwork quilt.

Ever since the World War and the signing of the Treaty of Versailles, a political revolution has been taking place in Europe. The communistic idea at the basis of the Russian state made way for an absolute dictatorship. Slowly Italy developed its Fascist form of government and today is an outstanding pronoment of this political institution. Germany started to rebuild the nation under Republican form of government, but after a series of reverses and failures it also has turned Fascist and has become an absolute State. France has gone through a kaleidoscopic series of changes in government, and a year ago it looked like a rather serious situation was developing with the left wing parties in the ascendancy. Today there is some indication of a swing toward the right but not enough yet to form a clear picture of the future.

Great Britain has more or less followed the routine conservative expectancy and over the more recent years has improved the internal situation, but is now in the midst of a hurried-up armament and preparedness program which makes it difficult to obtain a very clear picture of the future. There are undoubtedly possibilities of momentous political change in Great Britain, and yet this great country may move along quietly and without sudden departure from its ancient course of history.

The civil war in Spain has exercised an enormous influence upon European politics, in my opinion, far beyond the normal expectations at the time of its outbreak. Spain has become a testing ground for men and material of at least three European nations and in this manner has exerted an effect that is very difficult to measure.

But so much for the general European picture. Volumes have been written on the aims and aspirations of the various rulers and of the various political factions, and the newspapers carry an enormous amount of space devoted to the European political situation. Anything I may say would be mere repetition, and for our purposes here it is only necessary that we have a general picture so that we can draw upon the political developments in presenting to you their influence upon the chemical industry of the several countries.

In the first place there is varying recognition of the importance of chemistry to the political futures of the several countries. In consequence there have been various methods of approach to controlling this industry and directing its developments. Therefore, it would be only pure accident if all countries showed like trends. ~~This is not the case~~ As a matter of fact they do not, and it is necessary therefore that we discuss each in turn and look upon each nation's developments

as a national matter independent of all others to a very marked extent. As a matter of fact the nationalist policy of the world today has undoubtedly played a very large part in the picture that I am about to present to you. I therefore can but repeat that we must deal with each country as a unit, largely cut off from external influence and pursuing a program dictated by the governing element.

Let us start with Russia. There is some very good reason for choosing this country as the first one because the Russian chemist has been an outstanding individual in my branch of the science, and has made many excellent contributions, largely to the advancement of the theoretical side. When the Soviet government came into power it recognized that it was dealing with a very large population, some 160 million people, who were dependent upon a modestly developed mineral industry and a very extensively developed agriculture. We might also include forestry, for much of the country is wooded. In the days of the Empire there was comparatively little attention paid to manufacture. There were small smelters, iron and steel was produced in small quantity in several metallurgical centers, and there was a fair textile industry. But all in all Russia had developed along the lines of exchanging goods of the mines, forest and grain fields for imported manufactured goods. The Empire was often called the granary of Europe.

With the firm establishment of the Soviet in control of the country, the leaders determined upon an industrial development and aimed at supplying the needs of the vast population in their control. The First Five Year Plan was organized and put into operation with the idea of supplying capital goods and the products of the heavy industries. This was followed by the Second Five Year Plan which was theoretically designed to produce consumer goods, and it was naturally based upon the products of the First Five Year Plan. Up to this time, probably, there never had been such an attempt to change suddenly the habits of a nation and to build upon such a comprehensive plan. The engineering and construction talents of the world were combed for their designs and services. Equipment was purchased on a scale heretofore unknown, all with the idea of transforming the nation into a highly developed industrialized unit. There was no background of trained personnel upon which such industry could be erected. There was no competent direction in control of the program. Capital was acquired for carrying out the enormous works by a system akin to slavery, by starvation and tightening of the belt. If one were to write a specification for this program it might read as embracing all industry represented throughout the world with new units always larger in capacity and more complicated in design than had heretofore been produced even in highly industrialized countries. Size seemed to be the important criterion. The most modern of processes were adopted. The last word in projected design was hardly good enough to pass muster. It was on such a program that Russia built an enormous industrial plant and continued to add to it until a few years ago. But she has found that she cannot operate this modern and complex equipment with the available types of labor and the inadequate education of her superintendents and managers. In consequence production is far below schedule and there has been enormous wear and tear upon the units. Our newspapers continue to carry the stories of disorganization in the industrial establishments.

For two years now Russia has been essentially a closed book to the outsider. We know she has had many political troubles and these have spread into industry. It seems apparent that in these so-called purges she has destroyed much of the limited experience accumulated in the prior years of construction and operation, and as far as I can learn the industrialization of Russia is in a most chaotic state today. Many of the plants will have to be rebuilt for they have been destroyed more through incapacity and ignorance, than through sabotage. The qualities of products have nowhere matched anticipations. I therefore am of the opinion that, while not all has been lost, Russia is now finding herself in the position of having to grow industrially and the process of growth is always a slow one. It probably also is true that the present program of trying to force development in degree beyond present capacity is actually a hindrance to progress. I therefore look for continued chaos in Russian industry for many years to come and believe that we can continue to discount future Russian industrial possibilities.

For her chemical industry nothing particularly new has come out. The great creative chemists that Russia has always produced seem to have been lost in the political picture. There is nothing of a world-disturbing nature in the present chemical picture, in spite of odd items of propaganda from time to time intended to dispute this conclusion.

Turning next to Italy, we are dealing here with a much overpopulated country that is relatively short of raw materials and of food-stuffs. On the other hand there are many sections of this small country that produced excellent artisans and mechanics. The Italian engineer has given a good account of himself considering the relatively small number. The Italian has always been an excellent chemist and has furnished most of the theoretical background of my science. First of all, the country lacks adequate food supply and must import to a considerable extent. This situation has been improved in recent years, but not nearly to the point where the country is self-supporting. Secondly, Italy lacks coal. In turn, however, she has a rather highly-developed hydroelectric industry and can thus in part make up for the shortage of coal. It used to be said by visitors to Niagara Falls, as they looked across the industrial section and saw the great number of smoking chimneys in this ~~hydro~~ electro-chemical center, that it seemed very much as if hydroelectric power was only an excuse to turn coal. That is literally true of the electrochemical industry, situated as it is at Niagara, in a district where power prices are relatively high. It is not necessarily true when the thermal value of the electric current approaches that of the thermal value of coal. In consequence, in a country like Italy, possessing no fuel of consequence and with enormous <sup>water</sup> power resources that can be developed cheaply, it is possible to substitute electric energy for fuel to a material extent. One can reverse the process of turning fuel into electric energy by turning electric energy into steam in highly developed and efficient electric boilers. It is only a question of relative costs. In this respect Italy has taken advantage of her lack of fuel.

Italy does possess a highly developed chemical industry. She is utilizing the few natural resources to the limit and has developed the production of fertilizers, acids, alkalis and some of the

heavy chemicals sufficiently to meet her own requirements. Further, she has made some attempt at producing some of the more complex chemicals such as dyestuffs, and has an excellent working trade agreement with Germany, for importation of German chemicals, where her own production is inadequate to supply her needs. The excellent type of Italian worker, more particularly in northern Italy, has further led to the development of a very modern textile industry. These Italian textiles are finding their place all over the world, for the mills are modern, the designers are clever, and the weavers and dyers fully capable. I have always thought that Mr. Mussolini was very clever in his promotion of this industry, and that he followed events in Germany very closely. When the Nazi party began its anti-Semitic attacks it lost a great deal of the sympathy and many of the outlets of the German textile industry, and Italy stepped right into the breach with its new and modern plants, and filled its factories that formerly had gone to Germany.

All industry in Italy is closely controlled by the Government. It exercises power over the choice of executive staff. It determines upon plant expansions, their magnitude and direction. Indirectly in this way it controls research to a very remarkable extent. Through direct taxation it has acquired a very considerable share in the capital of all industry, including chemistry, and will undoubtedly continue its policy of closer and closer management. It therefore is certain that the chemical industry of Italy progresses only with the sanction of the state and in the direction that politics decrees. Italy itself is in a bad way financially. Foreign exchange is limited in quantity and is diverted largely in the direction of advancing armament and defense. It is no longer a country of free development, and we must interpret its future, as far as the chemical industry is concerned, in the light of these facts.

There are two developments of moment at the present time in my industry in Italy that I must mention. There is a considerable interest today in oil production by one of the several synthetic processes. Just what they will do for coal I do not know. It can be presumed that some of their interests in Spain lies in the direction of acquiring control of some of the Spanish coals, but nevertheless there is one country in between, so that shipment will have to be made by the water route, and that may not be an assured road. There is some coal over in Jugoslavia, but that again is another country. The extreme southern part of Austria also carries coal, and the German moves in that direction coupled with the Italian agreements, may have been somewhat influenced by Italy's need for solid fuel, not only for her industry, but as a basis of the synthetic oils. It is a very interesting situation, and may play an important part in European politics in the near future.

Italy is short of timber and has made important researches in the transformation of straw into cellulose, ~~an~~ turn an important raw material in the paper and textile industries. I think this latter development merits attention as one of the recent contributions of Italy to the raw material situation and is a problem which faces other parts of the world. With plenty of straw and hydroelectric energy it looks as though she will be able to supply a satisfactory cellulose under abnormal conditions.

We will turn next to Germany. In this country the close of the Franco-Prussian war marked the beginning of an enormous industrial development. The prewar Germany was not too well supplied with materials. ~~xxxxxxxxxxxxxxxxxxxx~~ Following the Treaty of Versailles the supply was still shorter. In consequence the Germans undertook a comprehensive scheme of education in the arts and sciences and added to this an excellent training in artisanship. There was thus developed a great force of engineers, scientists and mechanics serving as a background for an industrial development of the highest character. The soils of Germany are rather poor for the most part, and the densely populated areas could not hope to supply a balanced food requirement. The wise leaders of government early determined upon an ~~xxxxxx~~ industrial program that would exchange complex chemicals, machine tools, equipment and the like for the lacking food. She became preeminent in the design and construction of electric equipment, machine tools, of the more expensive chemicals and dyestuffs, and of fine textiles. Thus she could import the ~~xxx~~ low-priced crudes and raw materials and turn them out into the world's markets as highly refined precision equipment, pharmaceuticals, and colors. In this way she could capitalize to the greatest extent on the intelligence, education and skill of her people. I have always believed that this intensive export policy of the Germans had more to do with bringing about the World War than any other single factor. She literally had to fight for her markets, either offensively or defensively. The real argument is which, - was it offensive or defensive? and we leave that to someone else to settle.

This wonderful industrial machine of Germany as it existed prior to the war was completely turned over to wartime production since export soon became out of the question. In consequence, at the close of the war it was rather badly disorganized and required rebuilding. The postwar inflation period caused a redistribution of capital and the industries profited rather well, coming through it to a very considerable degree with modernized plants and increased productive capacity. The republican form of government, however, was republican in name only. It seemed to be pulled over to the left by a rather strong majority and really became a labor autocracy. More and more difficulty arose in attempting to use the modernized industrial machine, and finally there came the rise of a national socialist democratic party which overthrew the so-called republic to form the Third Reich. Ever since Mr. Hitler came into power there has been a struggle to get this industrial machine into operation and to capitalize upon its productivity.

The subsequent history has been one of what I consider to be a huge series of mistakes. It is quite evident to all and is very easily conformed by the thinking class in Germany that the leaders of the Nazi party are entirely inexperienced in government, have no knowledge of world trade and of industry, in fact, we are plainly told that they are not too well endowed with intelligence. The consequence of all this is that difficulties have arisen in getting this industrial machine into working order and the country today is in desperate need of foreign credits and exchange, to purchase the lacking foodstuffs and the raw materials not produced in Germany.

Following the example of all governments that find themselves in difficulties, the leaders have seized more and more power in the belief that their failure was due to lack of more complete control. This is not a foreign idea to us here, for the same thing has been expressed frequently in government circles in this city. It seems to be a fundamental error and a universal trait of most governmental agencies.

As a result, today we consider Germany as one of the most absolute autocracies in the world. Every phase of private life, of industry, of agriculture and transportation are all under the closest governmental control and supervision. It is questionable if prewar Russia had anything like as close supervision or as intensive police control of its people as now exists in Germany. It is quite certain that the leaders of old Russia were probably much more intelligent than those today in Germany.

We therefore can understand the present situation in Germany if we take to heart the statements I have just made above. The Third Reich determined to correct some of the so-called abuses of the Treaty of Versailles. For this it required an army of offense. Every energy has been devoted to the rapid construction of such force, and to its complete equipment. Every industry has been forced to contribute to the utmost. Service to the army could not be more complete if Germany was in a state of war.

Copying the Italian system, education for state service begins with the kindergarten. The labor unions have been abolished, as they previously had been in Italy, and fixed rules of service and of pay have been put into force. The Russian system, which does not distinguish between the party and the state, has been adopted, and the party has taken over supervision and control of industry in its most minute detail. They have not yet copied the Italian system of taxing a part of industry into the state, but that is not far in the future. In fact, in their treatment of the Semitic group the state has already acquired a very considerable financial interest in industry, and undoubtedly through ~~the~~ future capital taxation, will accumulate more. Personnel in the higher brackets is dictated to some extent by the party, which I confess I cannot distinguish from the state, even though there is a distinction. The worst feature, however, of all, is the petty graft, the "racket" as I call it, that prevails throughout all of the social system of Germany. The party must be kept active since it is the dynamic force behind the propaganda. The individual party worker must be paid for this service. This is where the racket comes into the situation.

The difficulties with acquisition of ~~raw~~ raw materials, most of which come from outside the country, has led to a number of governmental edicts limiting the quantities imported and decreeing the use of substitutes. Copying the Russian system of a Four-Year plan of controlled development of substitute materials, is now going into its third year. The chemical industry is particularly affected by this program since it has to do most of the research and development of the substitute.

Of primary importance is the production of synthetic oils. The actual capacity of operating units today is this field is unknown to the outside world. Originally the plan was to produce one million tons per year of liquid fuel. This was increased to two million tons before the first step had been accomplished. What it is now, no one seems to know. There are two processes in extensive operation in Germany; the original or Bergius process modified by the I.G. Chemical Company and known as the coal-hydrogenation process. I think the whole is somewhat of a misnomer, and that to date comparatively little solid coal has been hydrogenated to produce a liquid fuel. By far the largest production from these units came from the hydrogenation of coal tars and not the tars from lignite. As a matter of fact, an official document of only a little more than a year ago stated that progress is slowly being made in the hydrogenation of coal and it is anticipated that the first operating plants will be in operation in the near future, which would bring the time somewhere into 1938. Now, do not misunderstand me; there is plenty of liquid fuel being produced by this process, but I believe most of it is a hydrogenation of tars and not of solid coal.

The second process that has received a great deal of attention and is represented in a number of units, goes under the name of the Fischer-Tropf process. In this process, a gaseous mixture of carbon monoxide and hydrogen is passed over a catalyst and produces a hydrocarbon. The degree of combination is influenced by the amount of contact with the catalyst and the kind of a catalyst. In this process it, therefore, is possible to produce hydrocarbons of great complexity and I have seen examples carrying from 16 to 20 carbon atoms in a molecule. The bulk of the production, however, is in much less complex form, and closely resembles certain of our petroleum. Whereas the Bergius process operated at enormously high pressures, the Fischer process operated at practically atmospheric pressure, although the last units put into service are expected to carry pressures of 10 to 15 atmospheres.

These synthetic oils or liquid fuels require a great deal of treatment before they can be used in commerce. They are chemically saturated compounds. The lighter members of such a series would, therefore correspond to what we used to call straight-run gasoline, more particularly of the Pennsylvania type. Some of you probably know that such gasolines cannot be used in the modern internal combustion engine motor because of their very high knock property. The higher boiling members of these synthetic oils are much like our paraffines and are solids at ordinary temperatures. There are some fractions that seem to promise to have lubrication value, or are at least capable of being converted to lubricants. Therefore it is necessary to crack these liquid fuels as first produced, and proceed with the usual petroleum refining scheme. This, of course, means a very considerable loss, since in the cracking there are large amounts of noncondensable gas formed, of value only as a fuel, and since the Fischer plants are in the coke-producing districts where there is a large surplus of coke-oven gas, the fuel value is not high.

It is not my intention to discuss the commercial side of these pictures, but such observations as I have made shows that these plants are producing motor fuels at a cost of about three to four times what the petroleum industry could deliver equivalent materials at the German ports. The problem however, is not one of ordinary economics, and must be looked at in the light of a nation requiring liquid fuels with limited foreign currency to purchase outside the country.

One interesting result of this excursion into the fuel industry is the enormous development of the Diesel engine abroad. The technical aspects of this are too complex to develop here, but it would not surprise me to see the internal-combustion motor very completely displaced within a few years if we can assume stability of the present German regime for that time.

The steel industry has been taken under the wing of the government. Germany lost her valuable iron ore deposits in Luxemburg and Lorraine, and for the rest, they are of such low grade they were never even cataloged as ores of iron. The steel industry was centered along the Rhine and in the Ruhr. The low-grade iron ore deposits are in central Germany, and enormous expenditures have been made upon plants for beneficiation for the erection of new blast furnaces to treat these new raw materials. Ultimately it is expected that the finishing mills will be moved into this section of central Germany given over to iron and steel production, but the task is too huge for present consideration. Therefore, it is expected that the pig iron and ingot steel will be made in central Germany and shipped to the Ruhr for finishing until such time as the whole industry can be moved.

Of great importance but of lesser moment, is the synthetic rubber industry. The key to these developments was research conducted here in our own country. The Germans have taken this fundamental data and have <sup>been</sup> energetically at work on it for fifteen years. They are now producing a half dozen varieties of rubber in some considerable quantity and it is expected that at about this time, the first really large plant will be in production. For raw materials they use calcium carbide, and have erected large new units in Saxony, producing electric power from brown coal. The production is to be at the rate of some 20,000 tons per year, at the start, with plans for increasing as rapidly as possible. They have made substantial improvements in the consumption of raw materials, and, if I am reliably informed, when the plants were projected two years ago they figured on ten tons of carbide per ton of rubber, and are now finding that they can probably get along on about five tons. I do not know how far the wish is father to the thought, since many of these details are very closely guarded. As to qualities, some of the varieties are useful for special purposes. At least one of them seems to be excellent for tire stock. It may interest you to know that I heard that, on the march to Vienna, which was rather a parade than a military advance, 40 percent of the mechanical equipment failed, mostly on account of rubber. On investigation, I even heard this figure raised to 60 per cent. I thought it was due to the use of synthetic rubber, but learned that it was ~~due~~ rather to the fabric in the tires than to the rubber itself. At any rate, it is pretty well known that the army refused to countenance any active warfare immediately after this experience on the road to Vienna, and I was informed that they expected it to require a year to replace the equipment that had failed. I do know that replacement is under way now, but I have no knowledge of how far it has gone. It has caused a very great disturbance in foreign exchange, for they had not counted on having to go out and suddenly pay for an additional amount of high-grade cotton for tire fabric.

There has been enormous development of the cellulose industry in Germany, since this now forms the principal raw material for textiles. They have developed a rather good grade of staple fibre which can be used in the ordinary textile equipment that formerly handled wool and cotton.

I must admit that the printed goods and material for women's clothing showed very clever use of color and design, all built around this staple fibre textile industry.

Correspondingly, one finds some interesting substitutes coming from the chemical laboratory to take the place of copper and brass, and the bearing metal industry. Aluminum which is now produced on a very greatly enlarged scale is substituting for copper and zinc, and the magnesium industry has been greatly enlarged. There seems to be little strikingly new, chemically, in these metal-producing industries, but there are a great many new alloys coming from the laboratories.

When we turn to England, we do not find this great activity, that is so prevalent in Germany and Italy. The chemical industry seems to be going along its conservative and even way, and yet the English are outstanding chemists. Several years ago under government auspices there was constructed a Bergius process for the production of liquid fuel. It was supposed to produce 75,000 tons per year liquid fuel from coal tar and 75,000 tons per year from coal. For a long time they did not even start the coal unit. I do not know how much coal is being liquefied in England today, but I do know that the Englishman has overcome some of the obstacles that have stood in the way and probably is ahead of the Germans in technology of coal liquefaction. The whole coal liquefaction scheme of Great Britain, however, has developed the fact that it requires an enormous capital investment and that the costs of production are enormously higher than imported fuel oil can be delivered at the English ports. I was told that they probably would not increase these liquefaction plants as a war emergency because of these facts, and that they had determined that for a lesser capital expenditure sufficient naval protection could be given to insure open lanes for oil transport, and that this was the program to be followed.

The English are building some additional munition plants, scattering them in various parts of Great Britain. There is a complete change in ~~the~~ the design of some of these plants to make them less vulnerable to aerial attack, and along these lines there is a very interesting oil storage plant going in along the main line of the railway between Southampton and London. They have tunneled into a chalk hill and buried this storage under a heavy covering of chalk. It can be seen easily by any travelers on the railway during the construction period but will soon be completed and covered up.

Beyond these new factors, there is little noticeable change in the English chemical industry. It had undertaken to develop strategically located plants in other countries, not from a military standpoint, but to protect its world markets upon which the future of Great Britain depends so heavily. Nothing new or striking in products has come out of England that merits attention here.

In our own country our industry has been undergoing a revolution in recent times. We used to look upon petroleum as a fuel, and appraise its value on a b.t.u. basis. This is still its most important outlet, by far. But on the other hand, more and more attention is being paid to petroleum as a raw material for the chemical industry. An enormously increased activity is noticeable in our research laboratories. The Patent Office here is literally swamped with applications covering chemical derivatives from petroleum and natural gas. We are undoubtedly crossing the threshold, but not very far advanced into a new development, which will furnish an outlet for increasing supplies of petroleum, not for its heating value, but as a chemical reagent capable of transformation into a multitude of new products.

In the field of synthetic rubber we also started with carbide. The future development is going to be from ethylene, a by-product of the oil industry. Solvents, plasticizers, synthetic resins, are going to come in increasing quantities from this raw material. No one can, at this time, predict how far the industry will depend in the future on petroleum for its future synthetic products.

The sulphuric acid industry seems now to have completely abandoned the chamber process for the contact method and we will probably see no more chamber plants built in this country. The field of plastics grows every day. Strangely enough the older ones can hold their own and the newer ones have to fight for a place. Perhaps some day this will be altered, but we have yet to find important new applications, or probably more correctly, fundamental new plastics to find important new places in our industry. I am not in this respect speaking of novelties which are essentially of small tonnage consumption.

Another important factor that is showing up in the development of our industry is the fact that by-products while useful, are not universally satisfactory, particularly as to source and available supply. Therefore, more attention is being paid to methods of production of what were long considered by-products, so that an independent industry can be built around them. For example, the petroleum industry is very hard at work on producing substitutes for products formerly derived from by-product coke-oven tar. Ultimately they may supply many of these products to help out supplies when the ovens themselves are down or unable to meet demands. A good beginning has been made in this direction and a great deal more is promised in the near future.

We used to rely upon mother nature entirely for the raw materials of our textile industry, cotton and wool, later wood. We are now facing synthetic substitutes, not of the rayon type in which cellulose from wood pulp has replaced the cotton strand, but rather of entirely new synthetic products of no relation to cellulosic base. These are synthetic products that can be spun into filaments of specific properties which gives them a place in the production of the yarn from which the textile is made. For a long time they are going to be devoted to specific novelty purposes. It is always difficult for the chemical laboratory to compete with mother nature, particularly in these days of surplus farm production. Nevertheless we can look upon these synthetic fibers, not related to cellulose in any way, as an important beginning in a new chemical venture.

Before closing I should probably speak a few words of the effect of the recent changes in the map of Europe upon the chemical industry. Modern Austria possessed a comparatively small chemical development. A few chemical novelties were produced in Vienna. There is a highly developed magnesite in the southern part. It has been largely under German management, and Nazi politics predominated. In this district, and without further direct knowledge, I think we can assume that about the only change has been to bring these institutions under the German regime. The principal influence, therefore, would be felt through new export conditions, as Austria had in some respects more favored treaties than Germany. There is coal and iron ore in the southern part of Austria, but not of great importance. Transport to Germany would be long and costly, and these will not play any great part in German economy. Austria possessed relatively more timber land than Germany. It is possible that lumber and pulp might help the German situation.

The Sudeten area is a somewhat different story. Running north and south along the Saxon and Bavarian frontiers is a deposit of very excellent lignite. The country, for the greater part, is too rolling for intensive agriculture. There has long been a highly developed industrial section in this Sudeten area because of the advantageous supplies of cheap fuel and electric current produced from it. The chemical industry was quite well represented in this area, there being carbide, ferroalloy, heavy chemical, dye, pharmaceutical, soap, alkali and glass plants. There is also a well-developed metallurgical industry in this area. One of the chemical plants represented an investment of well over 30 million dollars. The largest of these chemical plants, I understand, has been absorbed into the German chemical combine. Nothing definite seems to have been determined in respect to the great number of small plants. A corollary of this situation is, how much of the production that passed into German hands will be duplicated in eastern Slovakia. There is brown coal in that district, and a start was made at moving these institutions some time ago. New boundaries with Hungary, however, undoubtedly affect the earlier plans.

There is also another transformation taking place, in that many of these Czech firms located in the Sudeten area are liquidating and seeking new locations in other countries. Here we have a case where a relatively small change of boundary may have serious influences upon our chemical industry.

In these few words I have hastily sketched developments in my industry in Europe. There are similar developments taking place in other parts of the world. South Africa is promoting a small chemical industry. There are a number of little institutions springing up that will undoubtedly serve a local market. Economically the situation is quite unsound, since South Africa must depend upon a heavy export of gold, not to speak of a serious attempt at promoting agriculture.

Similarly South Africa is attempting to provide for some of its chemical requirements. Heavy chemicals, explosives, and some synthetic textiles are in the making.

There is a heavy movement of the chemical industry into India. Undoubtedly acceleration may be expected in this direction since this is in the hands of competent groups. The metallurgical industry is also expanding.

Even China had erected a few small modern chemical units prior to the Japanese war. As far as we know, most of them have been destroyed, but this indicates a trend of recent development to provide for at least the fundamentals in many of the more remote parts of the world. We can expect more of this in the future.

I trust this brief outline gives you some indication of what is happening in several parts of the world. I wish time permitted to go more into detail and cover additional countries, but that is not possible today.

I thank you

New York City  
February 28, 1939

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DISCUSSION  
following lecture by Dr. Walter S. Landis  
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February 28, 1939

Colonel Miles: I think we are all impressed by the completeness with which Dr. Landis has covered a tremendous field.

I would like to ask one question, Dr. Landis. What do you think is the possibility of alcohol as an internal combustion fuel as a possible substitute for other forms?

A. That is not a difficult question to answer, Alcohol itself can be used as a synthetic motor fuel. It requires a change in the design of the engine but we are easily competent to make those changes. It is all right. If I had to run an engine and that was the only fuel I had it would be all right. It puts me in the same situation, however, as the German and English are in with synthetic fuel. I can buy for the same B.T.U. basis, the same mileage basis, petroleum products, gasoline as you call it, at such a much lower price than alcohol that I would just simply prefer the cheaper product. There is the same situation abroad. You can get a perfectly good gasoline delivered at a German port, say for 6 cents a gallon. As near as I can figure out, this German synthetic motor fuel costs about 20 cents a gallon. The English have already announced their costs, that they can get gasoline delivered at the English ports, tax free, of course, for around 3 or 4 pence a gallon. Let us not be too exact because you know these prices fluctuate. But that is the story of alcohol. If we want to pay the bill we can run on it.

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Colonel Miles: What about the exhaustion of petroleum supply?

A. I just read within the last two weeks that the new petroleum reserves uncovered within the past -- well, that may happen, but we will not see it. By that time we may have perfected these synthetic processes to a point where they are not so expensive or we may be willing to pay more for our motor fuel.

Q. I was very much interested in your remarks regarding the Diesel engine. We have been led to believe recently that Germany was backing off considerably from the Diesel engine, at least for aircraft use, and for that reason I was surprised to hear that in the next few years if the present regime continued, they would throw away the spot Diesel engine entirely.

A. That is about the way I sized it up over there. I was in the Yonkers plant and I was very much surprised to see the amount of effort they had put upon this new Diesel airplane engine, which Yonkers is building. I couldn't bring back the drawings but I did bring back some photographs. That is a field so far from mine that I don't want to be held up as an expert in it. Most of the motors are either Diesel or gasoline. Remember that the gasoline vehicle is very common in both Italy and Germany, and the Diesel is very common in Germany because these fuels fit more particularly to it than the gasoline. I think there are more competent engineers on that phase of the picture than I. But the direction is toward Diesel largely because it is the logical outcome of the type of fuel to come out of these plants.

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Major Brophy: We have had reports of the very effective chemical bomb produced by Germany. I wonder if you would comment on that.

A. I don't know very much about it except the fact that so far as I know there is nothing new in gas warfare that we haven't known. If you want to go back, I think it is still the same old story, that mustard gas is still the best of all-round gases over there. There is no question about it. They have spent a great deal more attention abroad on the incendiary than on the chemically filled bomb. There is more activity in the building, more activity in the engineering of that type of equipment. I think chemically there is probably nothing very new.

Major Brophy: Doctor, I had reference to a report in the press. Senator Clark called upon General Arnold with regard to a certain bomb tried out in Spain <sup>which</sup> killed persons for a quarter of a mile. This was a bomb that threatened the situation.

A. I don't believe it, that is all I can say. Most of us don't realize that the German propoganda machine is probably the highest geared of all the machines over there. Don't forget that.

Q. Dr. Landis, we have had run certain tests and done a certain amount of aeronautic construction through plastics. Did you find any developments of that nature in Europe or any type of our development?

A. I found nothing surprisingly novel in the plastic industry abroad along airplane construction. They have gone more toward aluminum, magnesium, and silicon alloys. So far as I know, all the planes are essentially of that particular type. There has been an enormous develop-

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ment in the use of plastics abroad in the place of bearing metals, and you find surprisingly large and heavy machinery operating on -- let's call it bakelite bearings, lubricated with water, performing very successfully. You find that almost all light machinery now is exclusively provided with these molded bearings. That has probably been the most successful of all the substitutes over there. The textile industry is out because the textile, after all, is a development that we have had before us for years and years; rayon, cellulose, acetate, etc., we have known for years. But they suddenly have turned over a use of these molded bearings to an extent almost unbelievable.

Q. Doctor, in considering the international situation from the chemical viewpoint, we have a situation right next door to us which affects us a great deal -- that in Mexico. I don't believe there is any country where the industrial and political situation is as mixed as it is there right now. Do you think that Mexico will have somewhat the same experience of Russia because of lack of skilled ability to operate its industries? I wonder if you would give us your opinions on that situation.

A. I think that is true so far as I know, although I have had some experiences down there that contradict that, probably not important but nevertheless they throw a clue to what sometimes might develop. There has been a large industry in Mexico, a very large mining industry very largely under the direction of American engineers and American supervision, and it is a successful industry. There has been a smelting

industry down there in the same way. There has been a small textile industry, some textiles produced, velvets, cottons, and other goods. They grow cotton in Mexico, as you know. That has been largely under the supervision of German and Belgium engineers and it has worked out.

Now, to go back to the people. I had one of the most curious experiences there in Mexico. I was there a couple of years ago and a friend of mine said, "I would like to take you over to the mint." This was under the Cardenas regime. I said, "Can you go to the mint?" "Yes", he said, "I happen to be one of the inspectors on the commission that operates the mints, so I have to go over there every so often and report." He was an engineering man. We went to the mint, and he introduced me to the MintMaster. The Mint Master was a very intelligent native Mexican, not Spanish but of native Indian ancestry. He took me around the mint, and then said, "Now I want to show you my shops." I went into shops there in which there was nobody but natives, producing the finest, most precision equipment I have ever seen in my life, bar none. They had rebuilt the coin sorting machines down there because the others they bought, either here or in Europe, only ran a couple of years and became inaccurate. They produced a much better equipment than they bought. They were producing all of the scientific equipment for the observatories. They were dividing circles down there to a degree of precision that I don't think the world recognizes. It doesn't exist here. Those Indians down there have a degree of skill that we mustn't overlook. I never had such a surprising trip in my life as that one, the little side issue of the mint producing highly refined, scientific equipment, actually dividing circles to a degree that was almost unbelievable. I checked it against the

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microscope. All the machinery to do the precision work had been built down there too.

Q. Dr. Landis, you mentioned the use of magnesium as a substitute in Germany. I understand that our aircraft industry in this country is very much interested in magnesium castings and forgings and that we haven't been able to produce them satisfactorily over here. Is there some secret process they have or more technical development?

A. There is no secret process. I have seen their magnesium plants over there. I don't know, I seem to get around. I saw the new synthetic oil plant in August. You can get around over there if you know the way, in spite of the government. As far as I know, there is nothing new in the technique of magnesia. They are using the same process as Dow used in Midland. From that standpoint, we are producing the same metal. I think they have probably had more experience in the production of alloys because the use of magnesium alloys duralumin types, particularly magnesium is of no use as a construction material itself. I have a tobacco jar of pure magnesia at home that is even a failure. But the alloys have been long developed and used over there in a great many ways. I have seen many and many a truck in which the wheels are cast of magnesia and aluminum.

Q. I know that we experimented some years back with magnesium alloy crank cases for aeronautic engines and it wasn't very satisfactory.

A. They are perfectly satisfactory over there, but I think it is only a question of experience.

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Q. Would you tell us what is the effect on the industry of the present status of the Ethiopian venture, if any?

A. I can't tell you the effect of the Ethiopian venture on the industry because I don't think it plays any subnormal part. Of course, as you know, they are trying to move Italians down to Ethiopia. Now, you are moving them out of one place to another, and therefore the principal change that makes is the matter of transport of probably the same materials. There are no raw materials coming out of Ethiopia of any moment whatever, so it hasn't changed industry from that standpoint. There are no new demands of Ethiopia. The moving of a population doesn't create new demands in any way except possibly for road building machinery or something like that. The most important part, I think, is the statements that appear at odd intervals over there. First Ethiopia was going to be an enormous asset to Italy, and then some months later another statement comes out that they are very sorry to say that the returns from Ethiopia are going to be very slow, they are not quite materializing up to schedule. Then some six months after comes the report, "We are very sorry to state that the demands of Ethiopia for new credits, capital investment, are very much greater than we anticipated. It is all on the liability side of the sheet for a long time to come.

Q. Dr. Landis, in connection with the government control of the chemical industry in Italy you indicated that the control was very complete, and yet apparently the chemical industry in Italy has been making some wonderful progress. Do you believe that the industry would

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have -- I am thinking about government control of industry in this country which you spoke of in Italy, do you think the chemical industry would have progressed faster or slower without this government control, or, in that particular country was it necessary?

A. I think originally the effective government control in Italy was rather good in that it directed attention to the development of certain industries which gave Italy immediately an export market. I probably didn't dwell very much on that, but let me tell you a little story as an illustration.

Going over on an Italian ship some years ago I saw a gentleman on the ship who had crossed the Atlantic many times before. I didn't know his name, but I knew he was a commercial man. I said to him, "I have never seen you on an Italian ship before. What are you doing here? I know you are a business man." He said, "I am a buyer for a great wholesale house in the middle west, textile goods." His specialty was knitted goods. He said, "I always bought about \$6,000,000 worth of knitted goods a year in Germany, in Saxony, the great center of that industry. But my outlets throughout the middle west are very largely Jewish outlets. They run the stores and shops and will not handle German goods." Mr. Mussolini saw this situation apparently and he built up an enormous textile industry to take over this trade, and I am buying all these goods in Italy now." I ran across that man in Berlin afterwards and I said, "What are you doing here?" He said there was \$4,000 out of \$4,500,000 worth of goods that he couldn't get in France and Italy and he had to come to Saxony to fill out that line. There is a case of where economically somebody foresaw a

difficulty ahead of time and planned to meet it.

As to the effect of government control, I can't tell you except by the reaction I get from Italian people, and they say it has been an enormous handicap to have to go to the government to get a research worker, to get permission for a new unit in any plant, etc. As you know, the government has taken over taxation, they control 10 percent of all industry by this capital tax, and that is growing slowly. In the long run the industry again is going to deteriorate, but there was a situation where it was very effective.

Colonel Jones: Doctor, at the time of the Munich conference we had a fairly good line on the number of planes Germany had, but computing their requirements in, say, high octane fuel for two issues a day it didn't make sense in the amount of gasoline they would require. Would you care to comment on what you saw as to their storage capacity and ability to maintain those airplanes in the air?

A. No. You are asking me something I cannot tell you anything about. I can tell you that the maximum overall outside exaggerated capacity of the German airplane plants is 1,000 airplanes per month. I will admit that is exaggerated. The quality of those planes -- this I have to get from hearsay, I am not an expert in aviation -- is such that they have to figure a 25 percent casualty a year. Whether that is high or low I can't answer. You will have to answer that from your own experience.

Colonel Jones: What I am interested in is the amount of fuel.

A. That I cannot tell you. All I can tell you is that the synthetic

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productions is over a million tons a year. Now that would include Diesel as well as gasoline, and probably some lubricating oil because these synthetic plants produce anything from paraffin to gas. In addition, how much is stored I don't know. You have the figures, I presume. Petroleum production in Germany is nothing. I cannot answer what they have in storage at all. I can tell you that from the best advice over there it is conceded from a great many angles, not necessarily the fuel angles but other angles, that Germany could not conduct an active campaign over four weeks. Four weeks is given as the maximum, that is what I gained by nosing around over there.

Colonel Booth. Dr. Landis, I wonder if you would express an opinion about our plants at Muscle Shoals, as to the value of those plants for national defense purposes, taking into consideration the present state of the island.

A. They are very obsolete. There is nothing usable there except in an extreme emergency. The oxidation units are quite obsolete, the first ever built on this side of the water. Of course that cyanamid process we abandoned ourselves in our own plant. By 1927 we had a wholly new set-up. So from that standpoint I would say that plant, in the twenty years it has been in existence, is very much outmoded. I know it wouldn't be needed today. You have other oxidation capacity that would take care of it, and I don't think it would ever pay you to even try to run it.

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Colonel Miles: Dr. Landis, this morning, made a statement which interested me because of the fact that on this side of the water we find so few people who have the same point of view. He is a great admirer of the present British Premier, Mr. Neville Chamberlain, and his reasons which he gave to me were so clear and so important that I am going to ask him to express again what he said to me early today.

Dr. Landis: Do you want to start a real fight?

Colonel Miles: I just want them to get your point of view because I think it is a very useful point of view, and particularly about the liability which Germany has assumed over there.

Dr. Landis: I happen to be a commercial traveller, that is, my business is to travel around the world and find out what is going on. I have been doing that ever since long before the war and I have a great many acquaintances abroad. I would hate to count how many times I have been to Europe.

This morning we were talking about Sudetan Land and the whole situation over there. It is a country that I go into regularly. I have business connections and relations over there that I have had for many years, in the chemical industry, so that it is necessary that I go there and stay, and therefore I realize just about what the picture is.

You will recall that following the Treaty of Versailles it was determined to set up a series of nations upon the basis of so-called self-determination principle, that is, we were to pick out ethnologically

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certain peoples and set them up in a nation racially. And so they did. They divided up this heterogeneous Austria-Hungary that had anything from Croats on the south to Hungarians. The Hungarian, you know, is not a Slav. He goes back to the old Tartar and those Far Eastern tribes of people. Then they determined to divide these up on the principle of self-determination of nationalities. Each nation, each kind of people, was to set its own boundaries.

That is a very fine principle and I want you to mark that in your mind. That principle is one that is going to come up again in this little discussion. So the various political advisers that had to do with the following out of that treaty set out to map Europe over. However, it happens to be that that principle was only a principle. It wasn't a practicable possibility in any way, and certainly the carrying out of it was about as far from the principle as you could possibly get.

Let us take this country of Czechoslovakia. Instead of the boundaries being set by the ethnologists in a self-determination the boundaries were actually set by the military man; and the boundaries were made on the basis of military advantage and not on the basis of racial questions at all. So the boundary of Czechoslovakia was set -- those of you who can recall the maps will remember that it starts along the northern border of Austria, which is a hilly country. It turns right down the ridge, the watershed of the , and goes northward, a chain of mountains between Germany and Bohemia, rugged and hilly country, and they go right down that and swings northeast on the tops of the , and finally goes straight on the tops of the .

From a military standpoint that is probably a very fine boundary, but has nothing to do with the original principle of an ethnographical boundary. So, as a result of that there was in this country about a half million people who did not speak any Slovak tongue. They spoke German. They were Bohemians and their German is not unlike the German of Austria, the German of Saxony. It is German and they understood each other, and in that country over time immemorial the German speaking people for a large extent in this eastern boundary became quite industrially developed.

Germans flocked over the border. Schools were all in German. A very wonderful technical high school was set up called the German Technical High School. There was also a Slovak school of the same kind but everybody went to the German school, it was so much better. They produced very excellent engineers and very wonderful plants up and down the line. All industries, the glass works, the soap works, textile industries, metal working industries, <sup>were</sup> operated by German speaking people through that stretch. This particular part of Czechoslovakia furnished about 75 percent of the wherewithall to operate the country because it was wholly industrialized and it paid the bills, after Czechoslovakia was set up. Taxes or revenues were never collected from farmers. So Czechoslovakia did what happened in this country in '65. They sent the carpet baggers into this section. There was moved into this section over 200,000 Czechs, who didn't speak German, to take over all service they possibly could; the railroads, government owned; the telegraph, government owned; telephone, government owned; the city administrations, magistrates, policemen; everything

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filled up with Czechs all through that territory. I had a terrible row over there in August in the Post Office Department. I can speak German enough to get around. I had a piece of airplane mail I wanted to send to my home, and we just couldn't understand each other, in a country where everybody spoke German. Well, they just played about all the mean, miserable tricks in the world on these German speaking people. Those German schools, German newspapers, were censored. At one time they made them smear tar over all the German shops in those countries. They played all sorts of dirty tricks and used that as the source of an enormous amount of revenue for the state.

That broke, and it broke in the sense that these Germans felt they were badly persecuted. They couldn't bring their children up in schools where German was taught, and they couldn't hold service positions, if German. You know all those stories. So they appealed to Hitler, they organized, and gave Hitler the finest of all backing. They said, "Self-determination of nations, that is the way we set this Czechoslovakia up, and where do we come out? We haven't a say in this self-determination. The military set the boundary when it should have been set and included us in with the German speaking people." And that was a very good argument.

Now, when the troubles began -- I am talking in a few minutes about what developed in a period of 15 years -- the situation finally developed to a point where something had to be done in Germany for an outlet for certain serious situations there. They had these cries from the wilderness in this German speaking area and started trouble. The English sent over there the Runseman Commission, I ran across them, they were spread

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all over the country finding out the facts. I knew pretty well what they had. I didn't believe the Runsamun report would ever be published. I knew it was entirely against the Czechs, and had a great many very weighty arguments against the Czech treatment of this particular minority of this country. If I could believe what some of the observers found -- they found a lot more that didn't get out in any abstracts of that report that I saw. What were you going to do? Here was Great Britain certainly not prepared for any major warfare. Here was this situation. In his pocket was a damaging bit of evidence. Chamberlain couldn't pull it out, it was against the Czechs. I don't think there was anything else for him to do, and I think he did a masterful job. The difficulty should have been straightened out by the League of Nations or whatever set-up Czechoslovakia years ago when they started those people off on the right track of government. They should have taken them in hand and showed them the errors of their ways in handling this particular situation, and certainly everybody should be very sympathetic to the solution which Mr. Chamberlain made. He had a France that he couldn't count on at all. You didn't know in September what was going to happen in France. He had a situation back home that wasn't too happy. They were certainly a long way behind in any adequate preparedness. He had in his pocket a document that was not supporting any aggressive attitude against them. I think he did a perfectly good job.

I don't know whether you believe this side or not, but it is five times as far by airplane from London or England to Germany as it is from Germany to England. You must not lose sight of that fact.

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Colonel Miles: You also brought out the point that Germany in taking over Czechoslovakia and Austria had placed an economic burden on itself which Mr. Chamberlain may have seen.

Mr. Landis: It is well known in England. When they took over Austria it was predicted that it would be an asset to the German empire. There were certain timber resources and other resources. Actually, it turned out to be a terrific liability. Any German will tell you this, if he doesn't see a policeman around. Actually, there is less than 50 percent of the people of Austria in sympathy with Germany. The other 50 percent have to be policed. Austria has never been a self-supporting nation in food supplies. Therefore, she now has to draw on German food reserves, not heavy. There are only five million people were talking about there. But that is important, because those food reserves are the critical part of Germany. That is the thing that will break Germany if she breaks, if she collapses, if she has limited foreign reserves to buy food from. The policing in Austria has been terribly expensive. It has been a liability,

Now she goes into Sudetan Land and that is many more times a liability than Austria was. This Sudetan Land is industrialized, producing materials that are in competition with German industry, the same chemicals, the same glass, all the way through. So what she has added to a producing unit she has added additional producing unit not needed. She has not acquired any food. She has acquired another deficit because because the industrialized area had to draw upon the great foreign sections of Moravia and far eastern Czechoslovakia. Germany has to

supply that food. As near as we can figure out, it brings the critical food period from the six month peak to two months, without Austria and Czechoslovakia in this picture, plus the fact of an additional burden of production that Germany doesn't need. No raw material is worth more. The only thing in raw material is brown coal, and they have plenty of that in Germany. It is a very great liability. One day I heard the report that Germany talked about giving the Sudetan Land back. I don't think there is any truth in the report, but it is a liability.

Colonel Miles: I don't think we can impose on Dr. Landis any longer. We are indebted, not only for the description of the chemical industry but his willingness to spread before us his very accurate knowledge of conditions in Europe.