American Chemical Companies in the First World War

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The outbreak of the First World War caught America in a situation where American companies and consumers were threatened by a shortage of chemical materials. German chemicals were a major factor in food production and consumer goods throughout the industrialized world. Whether these American chemical companies were producing dyes for the production of paper, clothing, fertilizer, or munitions, the lack of imported German component chemicals threatened to drive prices to exorbitant levels or stop production altogether. In order for the American economy to not come to a halt during the course of the war, American chemical companies worked tirelessly to create their own chemical formulas, expand their production base, and gear towards full war production as the United States was slowly pulled into the conflict.

The United States initially had no interest in involving itself in a European war. In theory, the decision to remain neutral kept America out of the direct line of fire, and allowed it to sell to and buy materials from both warring sides. American companies sought to make profits by selling war materials, as well as civilian goods, to both the Entente powers, Great Britain, France, and Imperial Russia, as well as the Central Powers, Germany, and Austria-Hungary. Munition export sales created a massive boom in American business, though these were protested vigorously by pacifists, clergy, and nationalist groups within the United States.

However, the actual physical geography of the warring nations and military mastery of the sea by the Entente Powers quickly ensured that German chemicals could not reach American plants. The British Grand Fleet and French Navy had slowly been establishing a naval blockade to anything going into or out of Germany. Initially the British and French blockades enraged Americans: British and French warships could, and would, stop American merchant ships heading for Central Power ports. In the process of these stops, British and French sailors would search the ships for contraband and if this was found the ship and cargo were impounded. This was seen by Americans as a violation of their neutrality: in their view they should be able to trade anything with anyone as they were not a combatant nation. However, the United States shifted to more trade with the Entente Powers, as export to these nations was easiest.

Potash Fertilizer

Some of the most critical materials that were denied to American consumers involved the chemicals needed to create fertilizers. One of the most missed chemical compounds blocked from Americans was German potash. Potash is an alkaline potassium compound that can be used as a highly effective fertilizer. It is an essential ingredient of commercial fertilizer, which was
increasingly necessary for long-used fields.\(^1\) And since potassium is essential to plant life, without this central ingredient chemical fertilizers cannot effectively increase the yields of crops planted.

At the outbreak of the First World War, the best fields for this material were found in Germany and it had been a major source of their export wealth. European and American farmers used the potash as a way for plants to retain water, grow larger, and generally increase the productivity of their fields. American farmers had become quite reliant on German exports as the American chemical industry did not have an existing domestic source of potash.

Large German chemical corporate conglomerations, or better known as cartels, were not keen to share the formulas with foreign competitors and buyers. They jealously guarded their secrets and had a virtual monopoly on the production of potash. With the outbreak of war, German potash could no longer be exported to meet the demand. German cartels had for decades refused to manufacture their chemicals in American plants because the monopoly on those formulae and shipments was a major source of wealth for German owners, investors, and the German Government.

Due to the British blockade, supplies of potash and other chemicals could not be sent to the United States. In order to crush the German economy and military, Britain expanded its list of items that were deemed contraband. Any merchant ships going to Germany carrying foodstuffs, medical supplies, and an exhaustive list of other items, could be seized. In 1915, Germany, facing the reality that their merchant ships could not sail to America, initiated an embargo on potash. The logic behind the move was to prevent their potash from going to America and then being exported from there to England. Historian William Haynes, writing about the situation after the war, states:

   Even if our Government [United States] should obtain from the British free passage for this essential fertilizer material through the blockade, it was recognized that both English munition plants and farmlands were in as dire need of potash salts as ourselves. Under the circumstances, Germany would no doubt be as rigid in her embargo as was England in her blockade.\(^2\)

German potash stocks were used by Germany and Austria-Hungary to try and fend off famine in those empires during the war. Later, those same stocks of potash would be used to make up for the loss of imported sources of nitrate for making munitions. The potash was chemically altered, by the Haber synthetic-ammonia process, in order to make explosives for artillery shells and bombs, as well as propellants for bullets. Germany, along with most other countries in the world, received most of its salt-peter and nitrogen supplies from Chile. The British blockade prevented that supply from reaching Germany, prompting the need for other processes to obtain the materials. Haynes explains:

   In Germany this problem had a double meaning. To the Kaiser’s militaristic clique, which foresaw a British blockade of Chilean salt-peter, nitrogen was as important for explosives as for fertilizer.

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So while Wilhelm II rattled his sword noisily for several years, he did not throw away the scabbard until the Haber synthetic-ammonia process and its companion, the Ostwald process for the conversion of ammonia to nitric acid, had been perfected and tested.  

Starting in September 1914, American newspapers, politicians, and scholars quickly sought to assuage concerns from farmers about the loss of this core fertilizer component. An article published by The New York Times on 18 October 1914 discussed the issue: “A practical monopoly [sic] in the potash market has been maintained in America by German syndicates. The war’s embargo has brought a complete severance between supply and demand.” The reality of having almost no readily available large stocks of potash had the potential to drastically reduce American food supplies. American chemists were charged with finding an alternative compound to keep crops growing.

The lack of German potash forced American chemical companies to develop American potash or to find an alternative fertilizer to make up the shortfall. In an interview with the New York Globe, Dr. William H. Nichols stated “Stassfurt (Germany) potash supply, upon which the world depends, is, of course, entirely cut off. The American farmer may have to get along for the time being without potash fertilizers; but other substitutes will take their place for the present.” At the time Dr. Nicholas was Chairman of the Board of General Chemical Company and also the president of the Nichols Copper Company. His expertise was sought out in order to assure Americans that the shortages of potash would not cripple farmers. His advice in 1914 was simply that these vital chemicals could be obtained from alternate European or South American sources or could be lived without altogether.

By 1915, the lack of German potash and limited success of American chemists and chemicals to fill the gap was beginning to be felt. Prices of the remaining stock of potash soared and became increasingly cost-prohibitive to the average farmers. According to Corda (qtd. In Jensen) “the price remained fairly stable at about $8 to $10 a ton until 1911-12 when it began to rise, perhaps because of the unsettled political situation in Europe.” Measures needed to be taken to ensure that American farmers would be able to fertilize their fields. The price of potash would jump to nearly $150 per ton by 1917, an exorbitant cost that was prohibitive.

Suitable alternative sites for the production of potash inside American borders were in some cases found in the most unlikely of circumstance. Richard Jensen describes a perfect example of this process, by which the small towns of Antioch and Hoffland, Nebraska, became boomtowns because of the potash industry. “Early in 1917 several potash lakes were discovered on state-owned

3 Ibid, 57.
school land, and a company was quickly formed to lease the mineral rights.” These chemical companies had to quickly establish rights to take over the lakes, build the factories necessary to create the potash, and finally have transportation systems that would allow for the finished product to hit the market. The population of the towns swelled as workers and chemists swarmed in to build and labor in the plants.

Nebraska became a center of potash production, but it was by no means an easy process, nor was it the only state to have the rare materials. Twenty-one states in total would find the means to build 128 plants to create an American potash industry. The massive price of building these facilities was only exacerbated by the inflation that the original shortages of potash caused. J. W. Turrentine, writing in 1950, also describes the difficulty that American chemical companies had when confronted with creating the potash industry from the ground up:

The critical nature of the emergency did not permit technological research. On the contrary, potash was being extracted in many instances by main force and awkwardness. As a result, with the reappearance of German potash on the American market at a carefully regulated descending scale of prices, the wartime domestic industry faded away, with only three units surviving to recent years.  

The completion of the factories and the economic boom to those states lasted only two years: by 1919, the cheaper German potash began to become available again. Those newly built chemical potash factories ended up closing during and after 1919 as the profits of companies plummeted.

While potash fertilizer was important to food production inside the United States, it was also needed for non-food agricultural work. Cotton production in the Southern states also required fertilizers. The lack of German potash saw a precipitous fall in the amount of fertilizer available for Southern farmers. The lack of fertilizer had the potential effect of producing poor cotton crops, thus reducing the amount available for the export market. Edwin J. Clapp sums up the situation:

As a result of these conditions the use of fertilizer in this country for the agricultural season of 1915 was greatly curtailed. This was especially true of the cotton states, where a reduction of 40 to 50 per cent was reported. Such fertilizer as was used contained less potash than usual. The effect on the cotton crop may not be noticeably great for the year 1915; but if the war continues and in 1916 no more potash is available than this year, the results, according to agricultural experts, will be very marked.  

The United States produced far more cotton per year than its own industry consumed. This had been the case since cotton had become the major crop of the South during the nineteenth century. With the outbreak of World War I, the demand for additional supplies for textile industries all over the world had the potential to boost a slumping pre-war American economy. But if the lack of cheap, available chemical fertilizer could not be found, then cotton crops would fail and Southern farmers faced economic collapse. Over the course of the war, the cotton that was grown in the United States shifted away from export and was used instead domestically by American textile

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7 Jensen, 28.
9 Clapp, 243.
manufacturers. The lack of fertilizer, as well as foreign markets, saw the American cotton farmer drastically lose economic power.

The lack of potash affected the growth of crops on the Pacific coast of the United States as well. California had, and still has, a tremendous ability to grow foodstuffs that can be either consumed domestically or abroad. In order to keep those vast fields productive, scientists in California turned to a truly unique solution to the fertilizer shortage: seaweed would be a new major chemical component. As Peter Neushul states, “Responding to this wartime opportunity, enterprising American businessmen built a new industry designed to extract both potash and acetone from California’s giant kelp. Although short-lived, California’s World War I kelp industry was the largest ever created in the United States for the processing of plants from the ocean.”

Initially harvesting the kelp was hazardous and exhausting work for the people involved in the process. The earliest version of harvesting the plant was to physically haul the kelp out of the water and onto the ship, a difficult practice as the crew had to physically secure the kelp underwater and then hoist it up. This method was detrimental because the kelp stalk itself was displaced from the seabed and could not be regrown. Between 1917 and 1918, the kelp harvesting industry lined up its technological issues and began producing a vital alternative to German potash.

A vast kelp harvesting and processing industry was born along the California coastline in order to boost domestic potash production. Factories, ships, and railway lines were laid in order for the kelp to be harvested, dried, and finally processed into potash for use either in the United States or to be exported abroad. The kelp potash was used to supplement the fertilizer industry and in the application of munitions manufacturing.

**Potassium Nitrate as a Weapon**

Potash was an essential component in the manufacture of chemical fertilizers, but it can also be a key in the creation of munitions. A different blend of potassium and other chemical elements similar to potash is known as saltpeter, or potassium nitrate, an essential piece in black powder production. Saltpeter can be found in several varieties each of which has different applications.

The most sought after version, before and during the First World War, was Chilean sodium nitrate. This version of saltpeter comes from the deserts of Chile and was a major source of wealth for that South American country. By the end of the nineteenth century, the last major supplies of naturally occurring Chilean nitrate lay in the Atacama Desert.

By 1911, Chile was supplying the majority of the entire world in nitrates. European powers sought to have close ties to Chile hoping that favorable diplomatic relations would lead to a steady supply of nitrates. As mentioned above, Chilean nitrate was used to produce not only fertilizers, but propellants used for bullets, explosives used in artillery shells and bombs. According to Manuel Bastias Saaverda, “Before 1914, only one-fifth of all Chilean nitrate exports were consumed in the powder and explosives industry; almost four-fifths of all nitrate exports were used for military

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purposes thereafter.” \(^{11}\) Without the supply of this rare mineral for continuous manufacturing of munitions, a long war would be out of the question for potential combatants.

Germany had a massive advantage over the Allied Forces during the early years of the war due to stockpiling the Chilean nitrates in anticipation of war. It also had an additional edge because most of the enemy European nations needed German chemicals to manufacture their own munitions. This initial lack of extra nitrates to manufacture new munitions was a terror for both those Allied soldiers fighting in France and the people at home. This early German advantage was also tied to the fact the Britain and France had to switch their industries over to the large-scale manufacture of war goods, something that did not come into full effect until 1916.

This lack of munitions caused a number of issues for both the British and French militaries. Between 1914 and 1915, the rapid consumption of shells by artillery pieces on the Western Front meant that rationing of those munitions needed to take place. Allied forces that went onto the offensive and those launching counterattacks had strategically used their limited shell supply to maximum effect. Even the vaunted British and French fleets had to keep a close eye on the amount of heavy ammunition their ships used until newly implemented war production could match demand.

Initially the British government was quick to dismiss the shortfall of chemicals needed to replace munitions used on the frontlines. In addition to a lack of chemicals, some newspapers actually mentioned the lack of British chemical engineers to manufacture them. This issue was rather eloquently addressed by a *Times of London* article from 18 August 1914:

> We ought, however, at once to admit the real, if unpalatable, fact that we have not encouraged the technical side of chemical education, which is so necessary for the manufacture of fine chemicals, and that as a consequence we lack men with the necessary practical knowledge. \(^{12}\)

This practical viewpoint on the lack of chemists in Britain skilled at replicating many of the imported chemicals from Germany during 1914 was lost over the course of the war. Instead of focusing on the need to train the existing and new chemical engineers to help the war of munitions, the British government sought out other reasons for early shortfalls.

During 1914 and early 1915, the British government repeatedly claimed that the issue was not so much one of lack of supply or technical skill, rather they attributed it to a lack of will-power on the part of the workers in the existing plants. The government insisted that strikes organized by industrial workers consistently held up production rather than a lack of vital chemicals. In discussing a strike of engineers at Clyde, in *The Times* the Chief Industrial Commissioner for the British government, Sir George Askwith, said “I am by the Government that important munitions of war urgently required by the Navy and the Army are being held up by the present cessation of work.” \(^{13}\)

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This lack of chemical components for the British, as well as the French, left the Allies in a precarious position for resupplying their armies fighting the Central Powers. If the British couldn’t produce their own domestic supplies of munitions, another source of those rare chemicals needed to be found. One solution was to buy completed munitions from the United States. This was a risky move to undertake for both the British and Americans, as the sale of munitions to only select warring countries would technically violate American neutrality. The Allies could also not be one hundred percent sure whether that American munitions would go only to themselves and not be sold to the Central Powers.

The question of what exactly could be shipped to warring or neutral nations became a topic of great concern. The biggest initial concern for American companies, government officials, and private citizens was whether items deemed contraband would result in American ships being seized and impounded. Since the British Grand Fleet controlled the Atlantic Ocean and access to Continental ports, American ships were routinely stopped and searched by British warships. Those heading for German ports were seized while those heading to British or French ports were allowed to conduct their business. Americans did not see the war as a reason for their ships to be seized, as they believed that free trade with all parties should not be impinged upon.

This issue of arms sales led to great tensions between the American government and those governments of the belligerent nations. In 1915, Austria vehemently denounced the expansion of munitions plants inside the United States for the express purpose of manufacturing arms. Austria demanded that the United States stop the possible planned industrial expansion that would see new plants built alongside the already existing factories to supply weapons and ammunition. In a response piece to that focused on Austrian demands printed in the *New York Times*, the author lays out the Austrian argument succinctly:

> It [the Austrian Government], however, did protest against the creation of new and extension of existing plants for the manufacturing of and exporting of war materials to such an extent that the economic life of the United States has practically, so to say, become militarized…the concentration of a large part of the American working power toward one goal, namely, the supply of munitions…invalidates any reference to previous wars.  


The issue was not that American munitions were reaching Britain and France and not Austria; rather the Austrian government was arguing that if American industry started to focus strictly on the production of war material, the United States was no longer a neutral country. The Austrians knew that American arms and munitions would not be able to reach their ports but they did not demand a complete embargo. That type of demand would have also forced the Americans to violate their neutrality. If the Americans were forced by the Central Powers to enact an embargo, Britain and France would suffer for lack of those vital missing chemicals for munitions. The laws of war would dictate that the United States had chosen one side over another. American neutrality meant that some war materials would reach the Allies and not the Central Powers.

As more and more munitions were shipped from American ports, the awareness of just how much was being sent to the battlefield was realized. Regular reports discussing monthly shipments of munitions dawned on American public awareness. This awareness did raise questions among
Americans of whether they were actually neutral. The Austrian demands also raised a number of economic and moral issues. The pre-war American economy had been relatively weak; with the war, the economy was booming and items not available for manufacture in Europe ensured American prosperity and expansion. But what was the ethical cost of this war-material export industry?

Americans themselves were concerned about the legality, as well as the morality, of selling munitions to warring nations. Numerous letters to the editor and opinion pieces were printed discussing this topic between 1914 and America’s entry into the war in April 1917. The Atlantic Conference of German Baptists stated their moral objections and their desire to keep America from exporting any arms: “We therefore earnestly protest against any exportation of things which kill any of the warring nations of Europe.”

The New York Times published several op-eds by Professor Theodore Woolsey, a former International Law lecturer from Yale University, which discussed the legal and ethical morality of American munition sales. He argued that the United States treated both sets of belligerents equally which ensured American neutrality. His argument rests on the fact that both sides have equal access to buy U.S. arms, but that Germany cannot carry this out because of a lack of transportation across the Atlantic. He stated:

She [Germany] cannot transport, because she does not care to contest the control of the seas with her enemies. Have we [The United States] aught to do with that? To supplement her naval inferiority by denying the Allied the fruits of their superiority would be equivalent to sharing in the war on the German side…notice no complaints of our exports of munitions have come from the German Government.”

Later in the same article, Professor Woolsey pointedly expressed who he blamed for such complaints reaching the United States Government: “The opposition to the trade seems to come from two classes: 1) German sympathizers…and 2) those who are governed by their emotions rather than reason and respect for law.”

The flow of munitions from the United States to European battlefields did not slow down because of the arguments and protests against their sale; rather every month saw orders from Britain, France, and even Russia increase as the massive battlefield expenditures of ammunition swelled. The New York Times reported on 14 June 1915, “It was said yesterday that the serious shortage of ammunition by the British, French, and Russian armies has spurred manufacturers in this country to extraordinary efforts to forward supplies in the shortest amount of time.” It was reported that around $30 million worth of supplies went to the Allies that April. The New York Times in

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16 “Upholds Our Trade in War Munitions: Prof. Woolsey, Yale Authority Find no Legal or Ethical Objection to it,” The New York Times, July 23, 1915, p. 2.

17 Ibid., page 2.

September reported “that shipments of horses, mules, automobiles, aeroplanes, and explosives all classed as war supplies, aggregated nearly $50,000,000 in July.”

The monthly exports of munitions and other war supplies only increased in volume after 1915. The quantity of bullets and shells used in Europe, and further afield, grew as major land battles increased during 1916. The Battles of Verdun and the Somme alone consumed hundreds of thousands of heavy shells and millions of bullets. All of these munitions needed to be replaced and new stockpiles established. American industry increased by expanding existing plants and building new facilities.

Chemical companies inside the United States needed to increase their own production in order to fulfill the requirements of the ammunition plants. The manufacture of existing types of bullets and shells continued throughout the war in order to fulfill the orders sent from Allied governments. In addition to the older models, new types of weapons were also produced. Dow Chemical, based out of Midland, Michigan, invented a magnesium bullet, known today as a tracer bullet, which allowed soldiers to track where their bullets were traveling. “Dow was a major source of explosives and other chemicals, devoting 90 percent of its production to war material such as phenol and magnesium.” With nearly 90 percent of Dow Chemical’s production switched to war-materials, Austrian fears of American industrial expansion were confirmed.

In addition to magnesium production, Dow Chemical also received orders to begin production of mustard gas. Mustard gas is a chemical weapon that was developed late in the First World War. Germany was the first to use this weapon in 1917; before this the majority of chemical weapon attacks consisted of chlorine gas that suffocated the victims. Mustard gas was a new substance that could not only cause death by asphyxiation, but also painful blisters on any exposed tissue.

The U.S. Army requested that Dow Chemical produce the compounds necessary to create an American version of mustard gas. Dow Chemical produced and shipped out more than 100 tons’ worth of mustard oil. This mustard oil could then be added into specially designed artillery shells. Once those shells were fired and exploded, the mustard oil went from a liquid to an aerosol form which permeated the battlefield. Even with gas masks on, soldiers were not necessarily spared: the aerosol would land on uniforms and then soak into the material. The soaked uniforms would then transfer the oil onto skin and cause painful blisters to spread.

The U.S. Army deemed it necessary to have its own chemical warfare program to create new protection techniques for its soldiers as well as to produce its own chemical weapons. Since this was a new type of warfare, the United States had to build its resources almost from the ground up. Gas masks, antidotes, and chemically treated uniforms (to provide additional protection from attack) were just some of the things that American chemists needed to perfect. They had to

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decipher reports from the Allies as to what elements comprised the German chemical weapon compounds and experiment to see how to protect soldiers against them.

The U.S. Army used controlled exposure to tear gas in training (another chemical weapon developed early in the War) to give American soldiers a better understanding of how to prepare and defend against chemical attacks. This gave the soldiers a firsthand experience as to the effects of the chemical without a gas mask, allowing them a personal example of how quickly these chemicals can be debilitating. In 1917, American soldiers were given additional training as they arrived in France by British and French officers who had survived German chemical attacks.

**Conclusion**

American chemical companies during the First World War proved to be essential to the victory of the Allies. Without American munitions and fertilizer flooding into Britain, France, and the United States itself, the early German advantage in chemical production may have given victory to the Central Powers. The millions of rounds of ammunition that were ordered and delivered to the Allies during the period of America’s neutrality helped to keep the British and French militaries fighting. By the time the United States entered the war in April 1917, the expansion of the American chemical companies in the immediately preceding years ensured that ammunition and chemical weapon production could match demand.

In addition, American efforts to create its own synthetic fertilizers from local products and chemicals gave the United States the ability to meet not only the needs of its own people, but those of the Allied nations as well. The ingenious use of either seaweed off the California coast or the exploitation of salt lakes in Nebraska gave a new source of potash. While prices of these artificial fertilizers were high, they did provide American farmers with a means to continue producing food and not bankrupt themselves. For many of the new fertilizer companies, the end of the war meant the closure of the plants that required so much time, money, and effort to build.

Once hostilities ceased, the American chemical companies were prepared to receive the cheaper, more plentiful German chemical compounds they expected. But they did not completely abandon the cooperation they had gained with the United States military. Instead, American chemical companies kept contact with the US Army and continued to develop new weapons and protection equipment. That relationship established in the First World War would be used again in World War II, Vietnam, and beyond. American chemical companies were, and continue to be, a two-edged blade: they have the ability to provide either life-giving or life-taking products depending on who makes the order.
Works Cited


“Upholds Our Trade in War Munitions: Prof. Woolsey, Yale Authority Find no Legal or Ethical Objection to it,” *The New York Times*, July 23 1915, p. 2.