

# Chemistry Triggered the First Civil Disobedience Movement in India

Indigo in Indian Independence – Role of a Broken Thermometer

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### **Chemistry as an Event Maker**

Although alchemy was never considered a science and its practitioners were frequently ridiculed, it gradually became the basis for later developments in chemistry, which may be considered to have beginnings in the 17th century. However noticeable impact of chemistry began to appear only in the second half of the 19th century. The present state of human civilization has been possible due to great strides made in chemistry as science and its role in modern technology. It is an interphase between the physical world on the one hand and the living organisms on the other. Chemistry supports and guides progress in many areas of physics and biology.

At times, a single, apparently initially insignificant discovery, that could even be accidental, can exert a tremendous influence on the social and political events of a small region or the whole world. There are hundreds of such examples. An event of great significance in modern Indian history was initiated by such an accidental observation during a reaction. It would be hard to believe that an accidental breaking of a thermometer in a BASF laboratory in Germany would in course of time lead to the first civil disobedience movement by Mahatma Gandhi in India. This is intimately interwoven with the development of the synthesis of indigo, an important dye even today.

### **The Indigo Connection**

The relationship of indigo with India is twofold. One, the name of the dye itself is a term derived from the name of the country. Indigo is believed to be the oldest natural dye as its preparation

#### **Keywords**

Indigo, Champaran, naphthalene, broken thermometer.



from leaves and use as dye are mentioned in Sanskrit writings more than 4000 years ago. (Egyptian mummy clothes also show the evidence of having been dyed with indigo). In ancient times everything that was imported into Europe from India was called *indicum* in Latin, the Greek version being *indikos*. In course of time, the word got associated with the blue dye only, probably because it was the most valuable substance from India then, and eventually became *indigo*. (The element *Indium* is so named because it produces indigo blue lines in its emission spectrum, and not in honour of India as in the case of Germanium or Polonium, etc.).

The second relationship is, as mentioned earlier, through its impact on social and political life of India especially during the second half of the 19th century and early part of the 20th century. We will return to this subject after considering some important aspects of indigo synthesis.

### Baeyer's Early Indigo Synthesis

Through the work of Baeyer and his coworkers starting from 1865, the structure of indigo was determined by 1880. Spurred by the success of his students Graebe and Liebermann in the synthesis of a natural dye alizarin in 1868, Baeyer undertook the synthesis of indigo and developed several methods within two years after the determination of its structure. Most of these methods made use of *o*-nitrocinnamic acid as the starting compound, prepared from *o*-nitrobenzaldehyde by Perkin reaction discovered a few years earlier. One sequence is given in *Structure 1*.

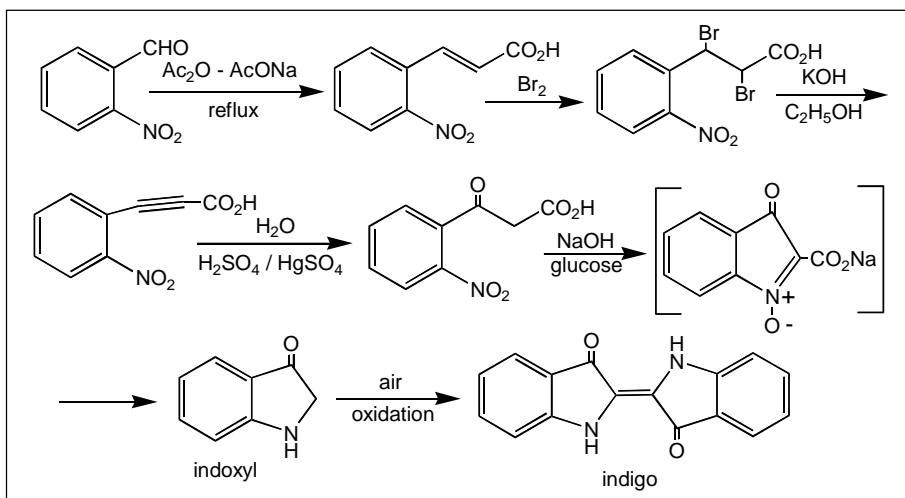
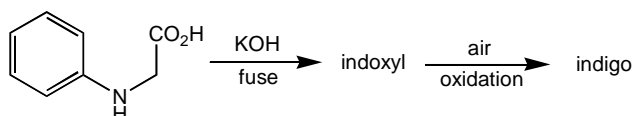
### Enter BASF

Though BASF bought the rights to these processes by paying Baeyer \$ 120,000/-, they could not be commercialized as the cost of production was much higher than the price of natural indigo. However, BASF, instead of giving up on the project, pursued it more vigorously. Heumann, who was assigned the work, developed the first feasible process, though not a very efficient one, in 1890 by fusing phenylglycine with KOH.

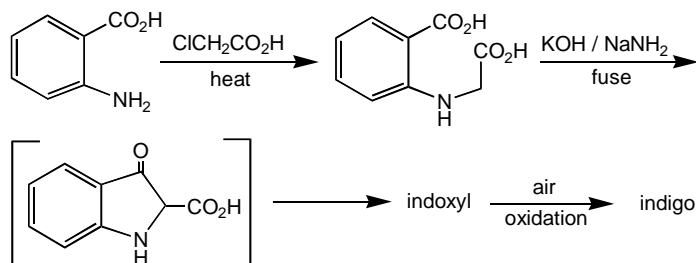
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**Structure 1.**

The actual commercial success came when Heumann used anthranilic acid as the starting compound in 1893 for developing the process outlined below.



The fusion of phenylglycine-*o*-carboxylic acid was more effective and indigo was obtained in high yield. BASF started its commercial scale production in 1897 based on this process. It seems that BASF spent around £ 1,000,000/- (\$ 6,000,000/-, then) for developing the synthesis of indigo. This indicates the potential profit that BASF was expecting to reap by selling synthetic indigo. Later work on the newer synthesis of phenylglycine and modified fusion process using NaOH, KOH, and NaNH<sub>2</sub> improved the yields of indoxyl starting from phenylglycine to the same level as from anthranilic acid. There-

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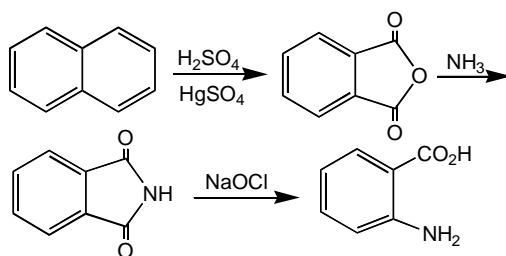
fore, commercial production of indigo went back again to phenylglycine.

In all this effort, the role of anthranilic acid for the initial successful commercialization of indigo process was very important. And economical manufacture of anthranilic acid was possible because a person by name Sapper broke a thermometer while heating naphthalene with conc.  $\text{H}_2\text{SO}_4$ .

### Nuisance Naphthalene and the Broken Thermometer

In the 19th century, naphthalene, a constituent of coal tar, had only nuisance value, and chemists were trying to find uses for it. Heating at high temperatures with strong  $\text{H}_2\text{SO}_4$  was one such attempt to convert naphthalene to phthalic anhydride. In this method the desired level of yield and quality of the product were not achieved. However, the goal was fulfilled most dramatically by accident when the thermometer, used to monitor the sulphonation temperature, broke and the mercury fell into the reaction mixture. Now the reaction was over in much shorter time and at moderate temperatures resulting in higher yield of better quality product. Thus was born by 'accident' an economical method for the synthesis of phthalic anhydride, which Heumann converted to anthranilic acid in two steps using Hofmann rearrangement. The cause for magical conversion of naphthalene to phthalic anhydride was mercuric sulphate formed by the reaction of  $\text{H}_2\text{SO}_4$  with the mercury dropped from the thermometer when it broke. Mercuric sulphate acted as a catalyst to speed up the conversion. Thus a seemingly innocuous accident had culminated in producing synthetic indigo at a cost much cheaper than that of natural dye. The seeds of civil

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**Indigo plant – *Indigofera tinctora*.**

disobedience movement in Champaran were thus sown in BASF, as the Indian farmers had to stop indigo cultivation.

(Phthalic anhydride is a very important industrial chemical, and is now manufactured by air oxidation of naphthalene in presence of catalysts such as  $V_2O_5$ ).

### **Mahatma goes to Champaran**

Until synthetic indigo came into the market, India had a near monopoly in the cultivation of indigo crop (*Indigofera tinctora*) and the export of the dye to Europe. (The dye occurs as the glucoside of indoxyl mainly in the leaves). The cultivation and processing of indigo, which involved boiling of the leaves in water and natural fermentation of the extract for a few days, was an important commercial activity in Bengal and the Champaran region of Bihar. The land in Champaran was cultivated by tenant *raiya*s, who had to pay certain rent to the landlord. It was obligatory for the tenant to use three *kathas* out of twenty (= 1 acre) for indigo cultivation, and was called the *tinkathia* (3/20 *katha*) system.

This is what Mahatma Gandhi writes about the condition of the indigo cultivators of the Champaran region:

“...I had seen packets of indigo, but little dreamed that it was grown and manufactured in Champaran at great hardship to thousands of agriculturists.” “... the *raiya*s are so crushed and fear stricken...”

Until synthetic indigo came into the market, India had a near monopoly in the cultivation of indigo crop (*Indigofera tinctora*) and the export of the dye to Europe.

“...Under the *tinkathia* system, the *raiya*t has been obliged to give his best land for the landlord’s crops; ...to give his best time and energy..., so that very little time has been left him for growing his own crops – his means of livelihood.”

“...the *raiya*t has to grow a crop on 3/20 of the holding at the will of the landlord for a stated consideration. There appears to be no legal warrant for it. The *raiya*s have always fought against it and have only yielded to force. They have not received adequate consideration for the services. When, however, owing to the



introduction of synthetic indigo the price of the local product fell, the planters desired to cancel the indigo *sattas* (agreement). They, therefore, devised a means of saddling the losses upon the *raiya*s. In leasehold lands they made the *raiya*s pay *tawan* (i.e., damages) to the extent of Rs. 100/- per *bigha* in consideration of their waiving their right to indigo cultivation. This, the *raiya*s claim, was done under coercion. Where *raiya*s could not find cash, hand-notes and mortgage bonds were made for payment in installments bearing interest at 12 per cent per annum. In these, the balance due has not been described as *tawan*, i.e., damages, but it has not been fictitiously treated as an advance to the *raiya*t for some purpose of his own”.

Following the introduction of synthetic indigo in mid-1890s, the indigo cultivation steadily lost its ‘colour’, and it turned from highly profitable occupation into a loss making business. The tenants had to give up indigo farming. However, this did not eliminate their obligation due to the *tinkathia* system. (For example, in 1893-94 the indigo was cultivated on 6,48,928 acres, in 1896-97 on 5,82,200 acres, in 1900-01 on 3,63,600 acres, in 1902-03 on 2,55,500 acres, and in 1905-06 on 170,000 acres.) It seems the tenants were coerced to compensate for the losses to the planters (landlords), subjecting them to further hardships. The local government (then in the hands of the British) had no interest in alleviating their plight.

### The First Civil Disobedience

By 1916, the situation had reached catastrophic proportions and the attention of Gandhiji turned towards this problem. In 1917, he intervened on behalf of the *raiya*s by going to Champaran to study the situation and conduct an enquiry. Sensing the trouble that would be caused by breach of peace in the locality and its consequences beyond, the government took immediate action.

In Gandhiji’s words:

“He (the messenger from the police superintendent) then served on me a notice to leave Champaran, and drove me to my place (in

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Bettiah, a village in Champaran). I wrote to the effect that I did not propose to comply with it and leave Champaran till my enquiry was finished. Thereupon I received a summons to take my trial the next day for disobeying the order to leave Champaran... ..I wanted to plead guilty to having disobeyed the order to leave Champaran...”

“...Before I could appear before the court to receive the sentence, the Magistrate sent a written message that the Lieutenant Governor had ordered the case against me to be withdrawn, and the collector wrote to me saying that I was at liberty to conduct the proposed enquiry, and that I might count on whatever help I needed from the officials... ..The country thus had its first direct object lesson in civil disobedience. The affair was freely discussed both locally and the press, and my enquiry got unexpected publicity...”

Thus, the breaking of a thermometer paved the way for cheaper synthetic indigo dye leading to loss of jobs and revenue to millions of people in Bengal and Bihar. The resulting misery gave birth to the civil disobedience movement led by Mahatma Gandhi, an important component in the struggle for Indian Independence.

### Suggested Reading

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