

CITY "SMOGS" IN PERIODS OF GENERAL FAIR WEATHER.

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Many cities using a large amount of soft coal are, under certain conditions and during periods when fair weather prevails generally over their respective regions, subject to visitations of smoke and fog combinations—recently called "smog"—of such density as to become quite annoying, interfering much with the usual activities of the area affected and causing considerable personal discomfort. At such times the darkness of night settles over the business or industrial sections, artificial light is usually necessary in buildings, street lighting is sometimes required and, somewhat more rarely, the density and penetration of the smoke-fog are such that a peculiar pungent odor similar to that of burned gunpowder is distinctly noticeable even within enclosed rooms.

An inspection of the weather maps over a period of several years at Indianapolis, and previously at Chicago, during the periods of these smog conditions, makes it apparent that the conditions favorable for the formation of smoke-fog are two:

(1) A high barometer, the sea-level reduction ranging from 30.1 to 30.6 inches, with the accompanying field of high pressure of faint gradient central over the city, or just passing over it, during the night preceding the occurrence; and,

(2) A late autumn, winter or early spring season, when the longer nights under clear skies render radiation especially effective in chilling the atmosphere to a point near saturation. The late autumn appears to be particularly favorable, probably for the same reasons that cause the more frequent occurrence of ground fogs during that time.

This slowly drifting area of high barometric pressure gives rise to clear skies over the general area in which the city is situated, while the faint gradient actuates but little lateral movement of the mass of surface air. In fact, the wind in such conditions often drops to two miles an hour or less, and sometimes appears to be altogether stagnant. There is, of course, often a slow settling of cooled air toward the ground as its density increases under radiation, and this slow settling may have some slight effect in retarding the initial rising tendency of the smoke volume. However, in any case, the lateral movement is entirely too slow to carry away the smoke as fast as it is vomited into the air.

The formation of the smog does not necessarily require a certain temperature, although usually the readings on the previous afternoon are moderate for the season and drop during the night to 10° above the freezing point or somewhat lower. With such temperatures at the lower end of the diurnal range—particularly in autumn, when the range is

rather large—ordinarily a point near saturation is reached during the latter part of the night or early morning. The chilling due to night radiation, however, is in the case under consideration of itself sufficient to produce very little or no fog, and the surrounding and residence sections of the city remain practically clear of both fog and smoke.

Now, sometime before daybreak, and usually attendant upon the unbanking and heavy coaling of large furnace fires in the business district in preparation for the coming day's activities, there is poured into this chilled atmosphere dense volumes of smoke from the numerous chimneys. The countless soot particles, rising at first and slowly spreading out, are chilled rapidly by conduction and radiation to temperature somewhat below that of the surrounding nearly saturated air. Condensation results upon these soot particles as their temperature passes the dew point, and with them as nuclei the formation of fog begins and proceeds increasingly. At the same time, this added moisture increases the weight of the particles sufficiently to arrest more shortly their upward movement and to cause them to descend more rapidly with the settling air to the levels of the street.

The weather continues quite clear overhead, the observer on exceptionally tall buildings or towers often seeing the sun rise entirely unobscured but at the same time being unable to discern objects on the streets below him. Those who live in the affected areas arise to a dark, gloomy, damp-feeling, chilly, depressive morning, sometimes disagreeably smelly of exploded gunpowder; while those living in the suburbs at the same moment are invigorated by a clear, snappy, zestful and bracing atmosphere. Passage from the one area into the other is as marked, and often nearly as sudden, as passing into or emerging from a long tunnel.

As this smog is brought about by the over chilling of smoke particles in an air already chilled to near saturation, it might naturally be expected that amelioration would set in immediately following the time of minimum air temperature shortly after sunrise. Ordinarily, however, this is not the case on the street and office levels, and the condition continues usually for two or three or more hours with practically undiminished intensity. The fog, indeed, may, and probably does, begin dissipation at its upper surface shortly after the temperature there begins its rise for the day, but the pall is so dense at its lower levels that the sun's rays do not penetrate, and there is no consequent rapid warming. The temperature shows only a slight rate of rise from the low point of the morning as compared with that of the outside area. There is for a short time, usually to be noted a gradual increase in the relative humidity, which, with the continued addition of smoke from chimneys, causes even an aggravation of the smog for some time after the minimum temperature is reached.

It is usual, therefore, for the dense combination to continue in the affected area until the warming up of the general air mass of the surrounding region has proceeded to a degree sufficient to give rise to convection currents that increase the lateral wind movement, and these often within a period of ten to fifteen minutes carry the pall away and restore normal conditions. The temperature, which has risen only

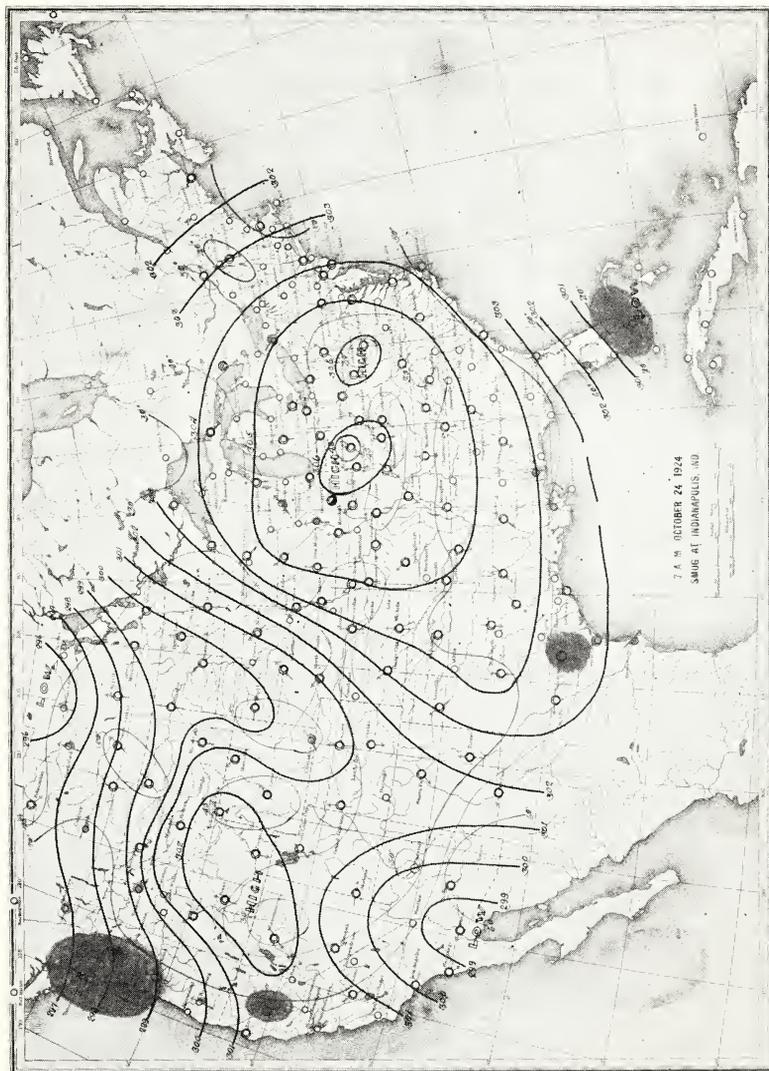


Fig. 1. Weather map of the United States for October 24, 1924, showing weather conditions favorable for smog at Indianapolis.

slowly under the blanket, in a very short time assumes that of the general air mass, while the relative humidity falls as rapidly and in corresponding measure.

On the night and morning of October 24, 1924, the distribution of the weather elements over the eastern half of the country was almost ideal for the formation of intense smog in the city of Indianapolis, as shown by the weather map of that date (fig. 1). An exceptionally large field of high barometer, drifting slowly southeastward over the Great Lakes and the Ohio Valley, was central directly over the city on the night in question, with a sea-level barometer at 7 a. m. of 30.6 inches. This occasioned an extensive area of clear skies over the eastern parts of the country, the only pronounced cloudiness within a great distance from Indianapolis being at Buffalo, where the expanse of Lake Erie to the westward toward the HIGH accounts for the formation of clouds at that place.

Owing to the very faint gradient throughout the region, as shown by the isobars, the wind in the exact center (Indianapolis) was more or less variable in direction, and dropped almost to a calm, being less than two miles an hour in velocity during practically the entire time from 3 a. m. to 10 a. m. It will be noted, however, that the wind directions at the surrounding weather bureau stations along the enclosing line of 30.6 inches tend toward the proper relation to that isobar, and the movement at these places was recorded generally as from five to nine miles an hour. At none of these surrounding stations was smog noticeable, although at most of them there was a varying amount of "city smoke," but at only one—Columbus, Ohio—was this reported as of more than the "usual amount".

At Indianapolis, however, smog of the most aggravated type occurred, beginning in the latter part of the night as smoke which later combined with fog and became so dense during the early morning hours as to necessitate the full complement of electric lights in the down-town office buildings. In the outskirts of the city the sky was at all times cloudless and there was no trace of smoke or fog; and while in the city the sky was clear and visible from the weather bureau tower on the roof of a 15-story building, on the street it was impossible to see any object more than one block distant. Just before 10 a. m. the rise in temperature was sufficient to promote convection. The wind increased to more than five miles an hour, and thereafter conditions became rapidly better, and the strong odor of the smog disappeared.

In common with Indianapolis, most other large cities, having congested business districts in which soft or inferior coals are burned extensively without sufficient care in firing or the use of smoke consumers, suffer from such visitations under the conditions described; and, it may reasonably be expected, will continue to so suffer until effective action has been taken to do away with the great volumes of soot poured into the atmosphere.