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Potential Health Hazards of the Leather Industry

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Introduction

This report presents the results of a cross section study of the physical environment of the leather industry from the viewpoint of real and potential health hazards incident to manufacturing processes, and of practical measures of control. A total of 62 plants distributed in 10 states was visited during 1939 and 1940, and inspected for possible health hazards. In the preliminary inspection, samples of material handled or air analyses made at isolated operations disclosed no significant hazard in some of the plants, while in others extensive surveys were not possible for some reason. In 38 plants, however, surveys with air analyses were subsequently conducted, the findings of which are recorded in this report. Included in the plants studied completely were 4 tanneries, 22 shoe factories, 3 sole and heel plants, and 9 plants manufacturing miscellaneous goods in connection with the leather industry.

In a few instances, where studies were conducted during the summer months, a recheck was made during the winter months when the windows and doors were closed, so that a comparison in fume and dust concentration could be made.

Leather Manufacturing Processes

Products Used

With the exception of skins from kangaroos, reptiles, and marine animals, the majority of hides and skins used in the industry are by-products of animals raised for their value to man as beasts of burden and as dairy producers, or slaughtered for their meat. These include the hides and skins from cattle, goats, calves, sheep, horses, water buffaloes deer, and elk—all having marked differences and suitable for a variety of purposes. Since these skins and hides may come from every country across the earth, they must be preserved from decay, and therefore are shipped already treated with some one of the preservatives. In some cases, arsenic compounds are used. The hides received at the tanneries are usually either dry-salted or green-salted, the latter being the more generally used method.

Many chemical agents are used in modern tanning methods. In one plant, for example, more than 250 different materials are used in the production of the leather. These include alkalies, acids, chromates, vegetable and synthetic tanning materials, oils, finishes and dyes. While certain of the dyes are derived from trees and plants, most of them are chemical products from the coal-tar compounds. Petroleum, tallow, wool grease, neatsfoot, linseed and other oils and greases, properly treated, are used in making a variety of types of leather and for replacing the natural oil removed in the hides and skins as a result of the tanning process.

Leather Making Processes

In order to convert the raw hides and skins into leather they must first be restored to their original flexible condition and the hair and flesh removed. The hides and skins are washed, fleshed, limed, bated, pickled, and tanned. They are cut and stamped and either washed in drums to remove dirt or tied together and soaked for at least 24 hours in "soaking vats" containing water, or in pits in which a paddle stirs the hides in the water. Germicides are used in the water to further disinfect the hides and prevent putrefaction. They are then trimmed and green fleshed and run through the lime vats for the purpose of loosening the epidermis or outer layer of skin in which the hair is embedded. There are several variations in the liming method. In some tanneries the solution used is a mixture of hydrated lime and dimethylamine which is added directly and sodium sulfide which may be piped into or added directly to the vats. In others, a small quantity of arsenic sulfide is used. This is weighed out by hand and added to the lime while it is being slaked. In some instances the hides are moved from one vat to the next by means of a reel, thereby minimizing personal contact with the solution.

After 3 to 10 days, the hides are removed, washed, and passed through the dehairing and defleshing machines. The hides are then rewashed and beamed. In beaming, the fine hair which escaped the machine is removed by means of a two-handled knife.

The older method, which consisted of sweating the hides by means of slow decomposition of the surface for the purpose of loosening the hair and then removing it with a blunt knife, was not encountered in the tanneries studied, although this method of removing the hair and flesh is said still to exist.

After the hides have been properly dehaired and fleshed, they are placed in a bating solution, in either drums or paddle vats, to remove the lime. The bating solution contains usually ammonium chloride and an enzyme compound. They are then pickled in vats containing a 1 to 2% sulfuric acid solution, to which sodium chloride has been added. They are again washed thoroughly in preparation for tanning operations and processes which convert them into leather.

All hides and skins, whether they are to be tanned by vegetable or chrome agents, receive about the same treatment up to this point. As a rule, the heavy leathers, such as harness leather and the majority of leathers used for luggage, as well as certain kinds of gloves and garment leather, are vegetable tanned. Chrome tanning is employed usually for shoe-upper leather made of cattle hides, goatskins and calfskins, and certain glove and garment leather.

Vegetable tanning consists of placing the hides and skins in tanning liquors of progressively increasing strength. Depending upon the desired results, this process may require from 2 to 6 months or longer. After passing through the series of vats, the liquor of each increasing in strength, they are placed flat in lay-away vats into which the liquor solution is then pumped until the hides are covered. The hides then pass through a scrubbing machine to remove the last traces of sediment or excess liquor. The finishing operations vary depending upon the use for which the leather is intended, but usually consist of restoring the oiliness which has been removed by the tanning process.

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The oil, or mixture of oils, is added to the leather while moist. The leather is then hung up to dry, generally in a darkened room, conditioned with moisture and good air circulation.

All chrome tanning processes are similar, but the solutions used and the method of treatment may vary. There are two methods in common use, the "two bath" system and the more recently developed "one bath" system.

In the "two bath" process the hides are placed in a solution of sodium bichromate and hydrochloric acid and milled, either in a drum or paddle vat, until the chromate has thoroughly penetrated the hide. They are then removed from the solution, allowed to drain, and placed in a solution of sodium thiosulfate (hypo) and hydrochloric acid for about 2 hours. The first bath saturates the hide with chromic oxide (chromic acid anhydride), and the second bath reduces the chromic oxide to basic chromic chloride, which, by the action of a sodium bicarbonate solution, forms chromic hydroxide, in which condition it will combine with the hide substance to form leather. It is while handling the hides saturated with chromic acid that formation of chrome sores or ulcers is most likely to occur.

In the "one bath" process the dichromate is reduced directly, usually by means of sulfuric acid, sodium thiosulfate and sugar. The hides are then milled in this colloidal solution of basic sulfate of chromium until tanning is complete. The "one bath" method is by far the more rapid, and, as it eliminates the handling of the hides saturated with chromic acid, is the less hazardous method.

The syntanning method is one of the latest developments in the tanning industry. It is simply tanning by means of the use of synthetic tanning agents. In one case the material used was an organic material prepared from sulfonic acid, caustic soda, Glaubers salt, formaldehyde, and water.

The tanned hides or skins are then washed, drained and milled in the drums with fat liquor and pigments. The fat liquor consists chiefly of an emulsion of cod and neatsfoot oil, either raw or sulfonated, and glycerine. The pigments are prepared in the pigment room and are carried in tubs and dumped into the drums.

The leather is stuffed with oil which is done by wringing the hides or skins to remove excess water, sammying to the correct moisture condition and stuffing in drums. The stuffing material may include mineral grease, cod-liver oil, wool grease, tallow and a small amount of sulfonated cod-liver oil, or other similar materials. The mixture is heated to about 140°F. with steam. The leather is placed in the drum and milled until saturated. The leather is then set, which consists of stretching the hide either by machine or hand to remove wrinkles and smooth out the grain, coated with an emulsion of wool grease and dried at 100°F. in an air tunnel. Following these operations, the leather is worked by machine to break down the fibers and render it more pliable, known as jacking, and the outer grain side of the leather is scoured, usually by means of a carborundum paper covered drum, although revolving blades may be used. This latter operation is called buffing.

Finishing may be done entirely by machine. The leather is passed through revolving rolls and contacts the finishing solution, which is fed into the trough of the machine and agitated continuously by an automatic stirrer. As the leather leaves the rolls, it passes over a conveyor belt where it is swabbed by a hand brush to secure even coating, racked, and placed in the drying chamber. A recent development in finishing the leather is that of spraying. The finish solution may be applied either by a hand-operated spray gun or by a machine in which the leather is sprayed automatically as it moves along on an endless belt. From the viewpoint of health and safety, the machine spray is to be preferred. In this, the hides enter one end of a completely enclosed unit, and are sprayed and dried before being removed. The finish solution may contain one or more solvents, waxes and resins, soap, milk, Irish moss, formaldehyde and small amounts of fusel oil. Organic dyes and the mineral pigments also are used. After finishing, the leather is burnished on wheels coated with carborundum paper, glazed, rolled and pressed. Large hydraulic presses usually are employed for leather pressing.

Where the quality of luster in the leather is desired, the leather is subjected to a glazing process by being rubbed with a glass cylinder. By still further varying the finishing process, the bright surface of patent leather is obtained. This consists of coating the grain surface of the leather with a varnish or lacquer, which, when dry, forms a bright, hard material, flexible enough to bend with the leather. In this process the colored leather is passed through a degreasing operation in which naphtha removes the surface grease. It is then stretched on frames and coated by hand with special paints or colors, usually a mixture of linseed oil and other materials, and the leather is either baked or exposed to sunlight and rubbed with pumice. This operation is repeated several times to ensure a finish which is bright and hard. Where suede surfaces are desired, the flesh side of the leather is buffed against a large rounded emery wheel which gives the leather the characteristic nap and soft texture of suede.

Shoe Manufacturing Processes

A variety of methods have been introduced and as many as 2,000 operations may be employed in making an ordinary shoe. Therefore, the processes observed in this survey can be described only in very general terms.

Cutting Department

The cutting of linings and upper parts of the shoe may be done by hand or by machine. Hand cutting is done on a hard wooden block, made especially for that purpose. The material is placed on the block and the pattern, which is made of metal or metal-bound template, is laid on the material, and the operator draws a short-bladed knife around the metal edge of the pattern. Machine cutting is done on a machine called the clicking machine. The leather is placed on the block and the operator sets a die upon the leather. He swings the beam of the machine over the die which is automatically pressed through the leather. The beam then returns to its original position. The edges of the uppers are sanded or roughed, and may be sprayed with a lacquer before being sent to the fitting room.

Fitting Department

The upper leather, lining, tongue and fittings are sewed or cemented together. Sewing is done almost entirely by machine, while cement is applied by both machine and by hand brushing. Ornamental perforations are backed by means of a lacquered tape which is moistened in a solvent, usually butyl acetate. It was noticed that in many plants petroleum naphtha rubber cement is being replaced by latex cement.

Stock Fitting Department

In this department the heels, soles, insoles, and other shoe parts are prepared for use. The sole is rounded, or cut to the desired shape, and sanded. It may be channeled, and, for certain type shoes, may be cemented, using either a rubber or a pyroxylin cement. Insoles are trimmed, sanded, and channeled. They are frequently stiffened by dipping in a solution of stiffening material in alcohol. The sock linings, slip soles, and leafs are cemented. In many plants, wooden heels are covered. The wooden heel is sanded and covered with either a leather or a celluloid cover. The leather covers are cemented in place with a rubber cement. The celluloid covers are soaked in a solution containing usually methyl alcohol, ethyl alcohol, acetone, ethyl acetate, or a mixture of these and other solvents, dried between cloths and applied to a heel which has been previously covered with celluloid cement. The covered heel is then sprayed with lacquer.

Lasting Department

In the lasting department, the uppers are joined to the insoles. The insole is tacked to the wooden last or, in some lasts, to lead "spots." These spots must be renewed from time to time by scraping out the old lead and refilling from a pot of molten lead. The last and the upper are then placed together, and by passing along a series of lasting machines, the upper is drawn firmly over the last and held in place by wire or tacks. A box toe may be inserted to give stiffness to the toe. This is usually made of leather or composition, and before use must be softened by steaming, soaking in water, treating with solvents, or in the latest development by the use of phosphoric acid. Latex cement is frequently applied to the upper to aid in holding it firmly in place.

Bottoming Department

The rough bottom of the insole is ground to remove excess upper leather, and sanded to prepare it for cementing. The shank is nailed or cemented in place, and the bottom evened by applying a filler, usually consisting of ground cork and coal tar pitch. The outsole is then attached. This may be done by sewing, by cementing or by a combination of the two methods. In some cases the outsole is attached to a welt which is fastened to the insole. The cement used may be either a petroleum naphtha rubber cement, or a pyroxylin cement. In making crêpe soled shoes, a benzol cement is still widely used. The heel is then tacked in place and is trimmed and sanded. The sole edges are trimmed, sanded and set.

Finishing Department

The rough shoe is finished, polished, inspected and packed. The soles and heels are sanded and buffed. Stains and wax finishes are applied. Scratches are repaired when possible, and dirt is removed by soap and water, ammonia or any one of several solvents. Some shoes are sprayed with lacquer. The finished shoe is then polished and is ready for shipment. In this department, as many as several hundred different waxes, polishes, dyes, stains and solvents may be used.

Sole and Heel Plants

In only a few cases did the shoe factories produce their own soles and heels. These were usually purchased, or in the case of larger companies, prepared in a separate factory.

The leather is dampened in water and the soles are cut out by machine. The soles are automatically cut or skived to an even thickness, and stamped to designate size and thickness. Heels are cut out by machine or by hand dies and mallets. The soles and heels are frequently waterproofed by immersion in an oil bath. Some heels are prepared from logs. The scrap leather is cut into sections and glued together under pressure in the form of a log which is then cut to the desired thickness.

Rands, shanks and counters are cut from scraps, usually by hand mallet. The final scrap is baled and sold.

Other Manufacturing Processes

Shoe manufacturers frequently conduct a variety of other manufacturing processes which may involve additional health hazards. A number of companies operate their own tanneries. Some maintain a chemical plant engaged in the production of materials used in the plants. These materials include rubber cements, dyes, polishes, soaps, rubberized cloth, and other materials. One company produces wooden lasts for use in various shoe plants. Another is engaged in the tanning and preparation of approximately 60 kinds of leather and operates a large harness and leather belt manufacturing plant, as well as a shoe manufacturing plant.

A few of the plants included in the survey confine their operations to special manufacturing processes. One company manufactures leather goods, such as men's belts, garters, braces, etc. This company also operates a metal department where various ornaments and fastenings are stamped from metal, assembled, in some instances by soldering, and then plated and buffed. Copper, brass, nickel, bronze, gold, and silver plating are done. The buffing compounds used include one containing a high percentage of silica. A second company confines leather work to the manufacture of shoe welts, a leather strip used to attach the shoe uppers to the soles, and conducts a branch business which involves the weaving of wool cloth and the manufacture of wearing apparel. A third purchases its leathers in the finished state and confines its operations to the manufacture of ladies' handbags from both natural and artificial leather. A fourth produces only upholstery leather. This company uses a variety of lacquers which are mixed in the plant. The hides, which are received tanned, are buffed and sanded to secure a smooth surface and even thickness, after which they are dyed in drums and tacked out for stretching and drying. A heavy dope coating is applied by hand. After drying, a color coating and a finish coat are sprayed on the hides. The various alcohols and acetates are the solvents used in the materials. Small quantities of methyl alcohol and benzol and larger quantities of toluol were found in the thinner and stock lacquer. Three other plants included could hardly be classified among leather manufacturers, since one is engaged in the manufacture of leather and woolen clothing, and the second in the manufacture of rubber heels and soles and canvas shoes, and the third in the sizing and finishing of cotton cloth.

Plant Conditions and Sanitary Facilities

The tanneries inspected in this survey are housed for the most part in series of one and two-story frame or brick buildings. The ground floor usually is concrete and upper floors are of wood construction. Natural ventilation by means of windows and doors is utilized and results frequently in drafty conditions during the winter months and high temperatures in summer. High relative humidities are usually present in the tanneries. A few of the tanneries, however, were of modern construction, well ventilated by mechanical means.

While a number of tanneries inspected had artificial illumination consisting of incandescent bulbs, many of which were improperly hung and unshaded, resulting in annoying glare and substandard intensity, the four tanneries in which complete studies were made (See Table A on Page 5) were adequately illuminated, utilizing both windows and skylights for natural illumination and augmented with well-shaded incandescent lamps of ample intensity. In a few plants, fluorescent type lamps were used, particularly in inspection departments.

Tanneries necessarily are odorous due to the nature of the materials handled. While objectionable to the casual visitor, workers employed in the tanneries soon becomes accustomed to the odors and apparently are not affected by them. Much of the tannery odor is caused by decomposing material which collects in cracks and corners. This odor can be reduced by frequent washing down of the floors and machines and by the prevention of accumulation of hide trimmings.

The chief agencies of injury in tanneries are the staking and fleshing machines, presses, beam cutters, moulding and embossing machines, and slippery floors. The types of accidents reported are those due to being "caught in or between" machinery, injuries to hands and fingers caught between moving parts, injuries due to striking against sharp objects, burning and scalding. Improper guarding of tanks is an important mechanical cause of serious accidents, and may result in a worker falling into the tank and being scalded to death. Tanks should be entirely enclosed. While safety devices have been installed and are maintained in some of the tanneries inspected, others have failed to avail themselves of these safeguards.

Only a few of the tanneries studied maintain a plant dispensary with a nurse in attendance and with adequate medical supervision. Others maintain a first-aid room made available to the management or certain employes having some knowledge of first-aid work for rendering emergency first aid to the injured. A number of these first-aid rooms, however, are not supplied with running water or with sufficient equipment, and are inadequately maintained.

Shoe factories and other leather manufacturing plants usually are housed in multistory buildings constructed of brick, stucco, or wood. They frequently are built in the shape of a U or an H, which provides a minimum width of floors for good natural illumination and ventilation. The majority of plants maintain a good standard of illumination and advantage is taken of natural daylight by frequent cleaning of windows. Shades, Venetian blinds, or awnings are used to control excessive glare. Natural illumination is augmented, where needed, by both general and localized lighting units. While natural ventilation by means of window control usually is utilized, air movement by means of electric fans is created during the summer months.

Washing and toilet facilities are provided and as a rule are well maintained; but the equipment, though adequate, was outmoded in a number of plants. Drinking water is provided in most instances by iced bubbler fountains, electrically cooled in several instances. It was noticed, however, in a few scattered plants that common drinking cups were in use. Housekeeping generally is good and the management is to be commended for the orderliness of material maintained in the various departments.

Plant dispensaries, adequately equipped and with a nurse in attendance, are more in evidence in shoe manufacturing plants than in tanneries. The injuries reported consist largely of injuries to the hands and fingers from machinery and needles in sewing machines. Electric shock from operating cutters and clicking machines is always a possibility in cutting departments.

Methods of Sampling and Analysis

Atmospheric dust samples were taken at the breathing level of workmen at various operations, using the impinger[1] and the midget impinger[2] for collecting the samples. The sampling solution used was either distilled water, alcohol or a mixture of the two, depending upon the type of dust present. Alcohol acts as a preservative to inhibit solution of the fine particles and to prevent the formation of aggregates of the fine particles by clumping.

In taking the sample, the apparatus was set up at the desired location, and air was pulled through the impinger at a rate of 1 cfm., or 1/10 cfm. for the midget impinger. The source of suction was either an electrically driven or a hand-operated vacuum pump. The sampling period usually lasted from 30 minutes to an hour to obtain a sample showing representative conditions.

Dust counts were made by the technique and methods developed and used by the U. S. Public Health Service.

The organic solvent vapors were determined by the interferometer or the combustible gas indicator. These instruments will show the total concentration of organic materials present in the air, but will not show what substances are present. Where the material being used was not known, or where there were several different solvents present, as in the case of lacquer, it was necessary to take a sample of the material being used for chemical analysis.

Tests for hydrogen sulfide or hydrogen cyanide were made by instruments designed specifically for these two materials.

Where it was necessary to determine the quantity of some toxic material present, as, for example, chromates, ammonia, formaldehyde etc. the sample was collected by bubbling the air through a suitable absorbing solution, using either the impinger or the fritted glass bubbling tube, and the material was determined by chemical analysis.

Health Hazards

Tanneries

Anthrax, a relatively rare yet serious infection when it occurs, may be contracted by workers from handling hides and skins imported from countries where anthrax among animals is prevalent. In a survey of anthrax reported by the several states, Smyth,[3] secured a record in the years 1934-1938 of 375 cases of which 61 were fatal. Workers in hides and skins accounted for 93 cases and 6 fatalities; the largest for any of the industrial groups listed.

The anthrax organisms enter the body usually through skin abrasions, such as cuts, scratches, or minor injuries, forming a malignant pustule of the skin at the point of entrance. Any small pimple, boil, or eruption appearing on the skin of the tannery worker should be seen immediately by the plant physician, and any worker with open cuts or sores on the exposed parts of the body should be kept out of contact with hides, hair, and wash water until completely healed. Antiserum should be employed if anthrax is suspected.

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[1] U. S. Public Health Service, Public Health Bulletin No. 217, 1935, J. J. Bloomfield and J. M. Dallavalle, Determination and Control of Industrial Dusts.

[2] U. S. Bureau of Mines, Report of Investigations 3360, December, 1937, Bureau of Mines Midget Impinger for Dust Sampling.

[3] American Public Health Assoc., Pittsburgh, Pa., Anthrax (A Twenty-year Survey of Anthrax in the U. S.)—Sixth Report of the Committee on Anthrax, Industrial Hygiene Section, October 11, 1939, published in American Public Health Assoc. Year Book, 1939-1940

Other skin infections, caused by the less dangerous pus-producing organisms, following skin injuries, are hazards present in all tannery jobs. An analysis of the number and cost of compensated infected injuries in 1932 by the Division of Statistics and Information of the New York State Department of Labor, showed that 25% of the compensated cases in the leather industry were infected injuries, where the proportion of workers thus infected in all industries was only 15.3%. The proportion in the leather industry was the third highest among the 36 groups reported upon.

Skin irritations from contact with a variety of chemical substances are frequent complaints among tannery employes. Since tanning processes are not completely standardized and vary with the manufacturer and with the type of leather manufactured, the chemicals used likewise vary as indicated elsewhere in the report. It is impossible in many instances to determine the particular chemical or mechanical agent responsible for initiating the skin irritation. The usual site of these skin irritations is first on parts of the body most exposed to direct contact with the irritating substance. Other parts of the body may be affected when the clothes are penetrated by the material. Caustic and acid burns are common. In chrome dermatitis the site of the lesion is practically always where the skin has been broken or injured. The lesions may appear as single or multiple ulcers, called "chrome holes" which may extend to the underlying tissues. Occasionally, irritation of the mucous membranes of the throat and nose, and even perforation of the nasal septum, may occur from inhaling chromic acid fumes liberated in the chrome tanning process or from direct contact with the chromates.

Other tanning agents, such as oak, sumac, and synthetic tannins may cause skin affections, as may also the various solvents, dyes, soaps, and oils used in certain processes. Some merely produce a redness of the skin, while others cause swelling and blisters in the early stages followed by peeling, crusting, and thickening of the skin in the later stages. The appearance of the lesion, however, seldom suggests a clue to the responsible irritant.

Skin affections as well as systemic poisoning may result from handling hides and skins which are treated with arsenic or mercury as preservatives. Arsenic also is sometimes used in dehairing processes. Harmful amounts of hydrogen sulphide may be present in box cars bringing skins and hides to the tannery and in cellars and hide houses in which they are stored. Workers engaged in cleaning sewer traps and sump tanks which collect waste material have been affected by hydrogen sulphide gas liberated from putrefaction of the fleshy materials.

TABLE A *(See Page 4)*

Grouping of Plants

Plants According to Type of Product Manufactured	Total	Number of Employees: Less than 100	100 and under 200	200 and under 500	500 and over	Per cent Female: Under 50%	50% and over	Plant Sanitation: Housekeeping: Excellent	Good	Fair	Congested	Personal facilities: Excellent	Good	Fair	Poor	Lighting: Excellent	Good	Fair	Poor
Tanneries	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Upper Leather	2	..	..	..	2	1	1	1	1	..	..	1	1	..	..	1	1	..	..
Leather	1	..	..	1	..	..	1	..	1	..	..	..	1	..	..	..	1	..	..
Leather, calf, miscellaneous	1	..	..	1	..	1	..	..	1	..	..	..	1	..	..	..	1	..	..
Shoe factories	22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Women's Shoes	14	..	..	6	8	..	14	3	8	2	1	1	12*	..	..	2	12	..	..
Men's Shoes	4	..	..	2	2	3	1	..	4	..	..	..	2	2	..	..	3§	..	..
Canvas Shoes	1	†	†	†	..	†	†	..	1	..	..	..	1	..	..	..	1	..	..
Children's and Infants' Shoes	1	..	..	1	..	..	1	..	1	..	..	..	1	..	..	..	1	..	..
Partial Survey	2	†	†	†	..	†	†	†	†	†	..	†	†	†	..	†	†	†	..
Sole and heel factories	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leather Soles, Heels and Counters	3	..	..	..	3	3	..	..	3	..	..	..	2	1	..	1	1	1	..
Miscellaneous	9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rubber Soles and Heels	1	..	..	..	1	..	1	..	1	..	..	..	1	..	..	..	1	..	..
Sized and Finished Cotton Cloth	1	1	..	..	..	..	1	..	1	..	..	..	1	..	..	..	1	..	..
Leather and Wool Clothing	1	..	..	1	..	..	1	1	..	..	..	..	1	..	..	1	..	..	..
Belts and Straps	1	..	..	..	1	..	1	..	1	..	..	..	1	..	..	1	..	..	..
Finished Upholstery Leather	1	1	..	..	..	‡	..	..	1	..	..	..	1	..	..	..	1	..	..
Welting and Textiles	1	..	..	..	1	..	1	.	1	..	..	..	..	1	..	..	1	..	..
Handbags	1	..	..	1	..	..	1	..	1	.	..	..	1	..	..	..	1	..	..
Dyes, Polishes, Cements	1	1	..	..	..	‡	..	..	1	..	..	..	1	..	..	..	1	..	..
Lambskin	1	†	†	†	..	†	†	†	†	†	..	†	†	†	..	†	†	†	.
Grand total plants	38	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

*One plant not recorded under personal facilities.
§One plant not recorded under lighting.
†Not recorded.
‡None.

Varying Temperatures, Humidities, and Wetness

Until complete mechanization of all wet processes in tanneries is attained, exposure of certain workers to wetness is unavoidable. Other workers whose duties necessitate entering the hot drying rooms are exposed to high temperatures, and processes in which steam is used add moisture to the air. During cold weather low temperatures and drafts are common in sections of the plant.

Some foreign observers have reported that rheumatic affections are especially prominent among those working in wet processes and that illnesses due to chills and respiratory diseases are above average.

Preventive Measures

A program of preventive measures against skin affections among tannery workers include a minimum of handling hides as they are transferred from vat to tank, and from tank to rack, and the maintenance of clean work places, floors, and equipment. Frequent mopping of soiled work places is necessary. The importance of adequate general ventilation and efficient local exhaust ventilation, where indicated, as preventive measures cannot be overstressed. The application of dope and lacquer-containing solvents always should be conducted under exhausted hoods.

Protective clothing includes rubber gloves, aprons, and boots. Where rubber gloves are worn, they must be kept in good repair, as any fluid between the rubber and the skin aggravates the hazard. Men should wear washable work clothing or overalls which can be kept clean. Ample toilet and washing facilities should be provided, and men should be required to take showers and change to clean clothing before leaving the plant. Men handling lime, soda, chrome, and other irritant substances should wash their hands frequently in running water, and clothing which has become saturated with solutions of these irritants or impregnated with dyes should be washed and dried before rewearing. The application of protective ointments, such as lanolin, castor oil, or a mixture of the two, may be effective in protecting exposed surfaces of the skin.

Workers should be instructed in the proper care of the skin, and be examined at frequent intervals by the plant physician for early evidence of skin diseases in order that they may be promptly cared for. Workers exposed to extremes of temperatures and high humidities should be provided with suitable protective clothing, and every effort should be made to maintain temperate air conditions through adequate heating and ventilation.

Shoe and Miscellaneous Leather Goods

Persistent forms of occupational dermatitis, particularly among polishers and finishers, are not at all unusual among workers of this group. The materials, many of them irritating, which are used in these processes, are so numerous that it is frequently difficult to determine the offending agent.

As is the case among tannery workers, the usual site of the skin lesion appears first on parts of the body most exposed to direct contact with the irritating substance, or on parts of the body covered with clothing which permits penetration by the material.

Although the various solvents used in the processes are responsible for many instances of skin irritation among these workers, alkalies, such as ammonia, and oxalic acid, also, are irritating agents. Leather dusts, more noticeable in the naumkeging departments where sanding and dusting are conducted, are mildly irritant to the skin as well as to the respiratory mucous membranes. An occasional individual may become sensitized to leather proteins and develop allergic reactions, such as skin affections and asthma. It is important that sanding and dusting be conducted under exhaust hoods large enough to be effective in exhausting the dusts.

Despite the relatively little dyeing of leather which is carried out in shoemaking, it should be remembered that leather pressers have been known to contract dermatitis from the fumes given off when the hot iron comes in contact with the leather. It is possible for the heat of the iron to decompose some of the dyes used on leather into their intermediates, or into other irritating compounds which are volatilized and are carried off in fumes. Blackening of heels and soles, as part of the finishing process, may give rise to skin irritation.

Good housekeeping, adequate ventilation (local and general), and protective clothing, discussed in the section on tanneries, are equally applicable to plants engaged in the making of shoes and miscellaneous leather goods.

Toxic Substances

Of interest from the point of view of this report, which is concerned with health hazards encountered in the industry, is the variety of chemical agents encountered in plants during this survey. These include lacquers, naphtha, gasoline, acetone, ethyl ether, ammonia, methanol, benzol, amyl acetate, ethyl alcohol, ethyl acetate, butyl acetate, butyl alcohol, carbon disulfide, carbon tetrachloride, cellosolve, toluol, coal tar pitch, dyes, lead, and phosphoric acid. The latter may release formaldehyde from the shoe. It is not to be inferred that all of these substances are used in every plant. In many instances only a few may be employed.

Plants have been grouped in Table A (See Page 5) according to the type of goods manufactured, approximate number of employes with percentage of female workers, and a general evaluation of housekeeping, personal facilities, and lighting. It is found that the industry engages a fairly high percentage of women workers, and, if this survey can be considered representative of the industry, that management generally appreciates the importance of good housekeeping, ample lighting, and the provision of personal facilities.

The substances found in the tanneries studied and their concentrations in the air are shown in Table 1. (Page 7).

The range of concentrations of solvent materials in the atmosphere at breathing level in shoe manufacturing plants is summarized in Table 2 (Page 9); the range of dust concentrations found in shoe factories in Table 3 (See Page 10).

Detailed information of solvent vapor concentrations found in the air at the breathing level of workers engaged in various departments and operations in shoe manufacturing plants is available in table form, and copies may be procured by writing to the authors.[4]

Discussion

Although the potential hazards of the leather industry as a whole are many, because of the variability of the processes and of the chemical agents employed, the health hazards in any one plant are comparatively few and can be controlled or greatly minimized without undue interference with the processes.

[4]Tables 4, 5 and 6, which are not printed here, are also on file at the American Documentation Institute, Offices of Science Service, 2101 Constitution Ave., Washington, D. C. Page 1 of Table 4 is printed on Page 11 as a sample; the whole table consisting of 13 pp.

TABLE 1

TANNERIES

Plant No.	Operation	Year	Number of samples collected	Substance determined	Millions of dust particles, less than 10 microns in greatest diameter, per cubic foot of air sampled	Concentration of vapors or fumes in parts per million of air	milligrams per cu. ft.	Approximate number of employes	Remarks
1	Buffing operations		3	Leather dust	4 – 4.8	......	......	211	Product: upper leather; domestic cow hides Tanning materials: chrome, some vegetable re-tan Type tanning: drum tanning Colors and dyes: synthetic dyes Finishing: water spray finish
2	Finishing dept. dusting hides		2	Titanox talc	4 – 7.2	......	......	650	Product: upper leather; domestic hides Processes: lime bath, sodium sulfite added Tanning materials: chrome with a small amount vegetable re-tan
	Finishing dept. spray room		3	Butyl alcohol, butyl acetate	......	160–300	......	......	Type tanning: drum tanning Colors and dyes: synthetic dyes Finishing: lacquer — hand and spray
	Finishing dept. topping leather		1	Butyl alcohol, butyl acetate	......	126	......	......	
3	Finishing dept. shaving and buffing hides		2	Leather dust	2 – 3.5	......	......	200*	Product: fancy leather and calf; foreign and domestic hides Processes: lime bath: arsenic sulfide added
	Finishing dept. hand finishing		12	Mixture of alcohols, acetates, toluol	......	80–280	......	......	Tanning materials: vegetable—small amount chrome
	spray finishing		8		......	100–400	......	......	Colors and dyes: synthetic dyes used chiefly Finishing: lacquer — hand and spray
	Finishing dept. hand dipping leather strip		8	Petroleum naphtha	......	20–120	......	......	
4	Buffing, burnishing and sanding hides	1939	5	Leather dust	8.1–12.0	......	......	880	Product: upper leather; 3700 hides a day; domestic cow hides
		1940	6	Leather dust	6.4–18.8	......	......	**	Process: vat and drum tanning
	Powdering machine	1939	1	Talc	14.6	......	......	......	Tanning materials: chrome and vegetable
		1940	1	Talc	7.8	......	......	......	Colors and dyes: vegetable and synthetic
	Water purifying plant dumping lime	1939	1	Calcium	......	......	.08	......	Finishing: lacquer and water spray
	Color mixing room	1939	1	Basic black dye	......	......	.05	......	
		1940	1	Basic black dye	......	......	.1	......	
	Stuffing room	1939	2	Acrolein	......	......	†	......	
	Beside pickling vats	1939	1	Sulphuric acid	......	......	.04	......	
		1940	1	Sulphuric acid	......	......	†	......	
		1939		Hydrochloric acid	......	......	†	......	

See Page 8 for Continuation of Table I

*25% female.
**30% female.
†Negative.

TABLE 1
TANNERIES
(Continued)

Plant No.	Operation	Number of samples collected		Substance determined	Millions of dust particles, less than 10 microns in greatest diameter, per cubic foot of air sampled	Concentration of vapors or fumes in parts per million of air	milligrams per cu. ft.	Approximate number of employes
4	(Continued)							
		1940		Hydrochloric acid	....	....	†	.....
	Preparing spew remover	1939	2	Ether	....	25–50	......	......
		1939	2	Benzol	....	100–120	......	......
	Compressor room	1939	5	Ammonia fumes	....	25–50	......	......
	Car unloading hide house	1939	12	Hydrogen cyanide	....	....	†	.....
	storage room beam house			Hydrogen sulfide	....	....	†	......
	Finishing dept.	1939	26	Ammonia	....	25–600	......	......
	hand finishing	1940	29	Ammonia	....	20–650	......	......
		1939	26	Alcohol, fusel oil,	....	20–100	......	.....
		1940	34	formaldehyde, celosolve, acetates, acetone, etc.	....	20–120	......	......
	Spray finishing	1939	6	Ammonia	....	....	†	......
		1940	6	Ammonia	....	....	†	......
	Chrome room beside operator	1940	1	Chromium	....	....	.058	......

†Negative.

The industry, through improved methods such as the "one-bath" tanning method which eliminates the handling of hides saturated with chromic acid, the substitution of machine spraying for hand spraying, and the increasing use of mechanized operations and labor-saving devices, has contributed greatly to the protection of its workers.

Certain plant operations do permit the escape of volatile toxic materials into the environmental atmosphere, and in some instances, unsafe concentrations are reached, particularly during the heating season when windows and doors are closed. Despite the tendency to substitute less toxic substances for toxic ones, such as the increasing use of petroleum naphtha as a solvent in a number of processes in place of the much more toxic benzol and its homologues, appreciable quantities of the latter, used either as such or in combination with other solvents, were found in the present survey.

In the foregoing study a total of 38 plants was surveyed and air analyses made at operations where potentially hazardous materials were handled. In 4 tanneries a total of 208 samples of the air were collected for dust counting and analysis for toxic substances and solvent vapors; in 22 shoe factories a total of over 585 air samples were collected and analyzed; in 3 sole and heel plants a total of 22 air samples were collected and analyzed; and in 9 plants manufacturing miscellaneous leather goods, approximately 150 air samples were taken and analyzed for a variety of substances.

In the tanneries *(Table 1)* among 96 samples analyzed for toxic solvent vapors, such as benzol, alcohol, acetates and mixtures of these used in finishing processes, only a few showed concentrations slightly exceeding the generally accepted safe limit for prolonged exposure. As a rule, spray finishing operations were protected with exhaust ventilation, but in handling the volatile solvents in other ways, such as the preparation of finishes, or their application by hand, natural ventilation was usually relied upon to remove the fumes. Among the air samples analyzed for ammonia, acids, acrolein, dyes, hydrogen sulphide, hydrogen cyanide, chromates, and lime, ammonia was the only one found to exceed the safe limit with any frequency. Chromic acid was present in excess of the permissible limit (0.1 mgm. per cubic meter) in the one operation sampled, but the operator was protected by a respirator, and the exposure was only intermittent in this case. Acrolein, hydrogen cyanide, and hydrogen sulphide could not be detected in the air in any of those processes in which they have been reported to be found. Dust counts made from 20 air samples taken at grinding, buffing, and powdering operations showed the highest count to be just under 20 million particles per cubic foot of air, while less than ¼ of all the samples showed counts exceeding 10 million particles per cubic foot. Analysis of the dust showed that it consisted chiefly of leather, talc, or titanox. The dust-producing operations were in most cases provided with adequate local exhaust ventilation. The concentrations found of this mixture of materials could not be considered harmful on the basis of present knowledge.

In the shoe factories among the 500 air samples collected around cementing, spraying, finishing, and cleaning operations, where organic solvents were used, the concentrations of solvent vapors found in the air ranged between

TABLE 2

Solvent Concentrations at Similar Typical Operations in Shoe Plants

Operation	No. operations studied	No. samples	Solvents used principally	Number of operations in various concentration ranges										
				0-25 p.p.m.	25-50 p.p.m.	50-100 p.p.m.	100-150 p.p.m.	150-200 p.p.m.	200-400 p.p.m.	400-600 p.p.m.	600-1000 p.p.m.	1000-1500 p.p.m.	1500-2000 p.p.m.	Over 2000 p.p.m.
Fitting dept.														
Cementing linings, assembling, etc.	26	113	Petroleum naphtha	1	10	8	1	....	3	1	2	...	....	....
Underlaying perforations	7	22	Acetates	1	4	2	....	....	..	.	....	....	....	....
Stock fitting														
Insole stiffening	11	33	Alcohol	1	4	4	2							..
Cementing sock lining	4	7	Petroleum naphtha	1	2	1					...	..	....	..
Cementing soles for stitched shoe	8	20	Petroleum naphtha	....	1	4	.	....	2	....	1	....	....	....
Cementing soles for cemented shoe	7	24	Ether, acetone, alcohol, acetates	..	....	3	1	....	1	1	....	1	....	....
Celluloid heel covering	7	45	Alcohol, ethyl acetate, acetone	....	2	2	2	....	....	....	....	....	....	1*
Leather heel covering	2	4	Petroleum naphtha	....	....	....	1	1	....	....	....	....	....	....
Lasting														
Cemented linings	3	8	Petroleum naphtha	1	2	....	....	....	....	....	....	....	....	....
Box toe softening	2	6	Acetates	....	1	1	....	....	....	....	....	....	....	....
Bottoming														
Cementing uppers stitched shoe	5	8	Petroleum naphtha	....	....	1	1	2	....	....	....	....	1	....
Cementing uppers cemented shoe	7	25	Ether, alcohol, acetone, acetates	....	1	3	1	....	2	....	...	....	....	....
Applying softener	9	30	Ether, alcohol, acetone, acetates	2	....	1	1	3	1	....	....	....	....	1
Cementing crepe soles	7	16	Benzol	1	1	1	1	....	2	....	....	1	....	....
Cementing uppers for crepe soles	3	11	Benzol	....	....	....	..	....	1	....	3	....	....	....
Laying crepe soles	4	12	Benzol	....	....	1	1	1	....	....	1	....	....	....
Channel cementing	11	43	Petroleum naphtha	....	1	2	5	1	1	....	1	....	....	....
Finishing dept.														
Cleaning shoes	7	20	Acetone, ether, petroleum naphtha	4	2	1	....	....	....	....	....	....	....	....
Treeing shoes	9	26	Ether, petroleum, naphtha	5	1	1	1	....	1	....	....	....	....	....
Spraying lacquer	8	19	Alcohol, acetates, 10-20% toluol	2	1	3	1	....	1**	....	....	....	....	....

*This figure represents 6100 parts per million of methyl alcohol.
**This figure represents 370 parts per million of benzol and toluol.

zero and 200 ppm in the majority of instances. In a number of plants, however, the concentrations exceeded safe limits or even dangerous limits, and this was especially true of operations where benzol was encountered. Although benzol was used as a solvent in only 7 of the 35 shoe plants studied, it was present in concentrations above the generally accepted permissible limit for prolonged exposure of 100 ppm of air in the majority of the operations in which it was used, principally in that of applying crêpe soles (*see Table 2*). In several other plants benzol was used in combination with other solvents. Toluol was generally used in mixtures, but may have been present in excessive concentrations in several operations. In one operation of celluloid heel covering where methyl alcohol was used, the vapors were found in dangerously high concentrations in the air. Acetone was found in excessively high concentrations in 2 samples taken at a bottom cementing and a sole laying operation in the same plant.

In grinding, buffing, cutting and powdering operations, the dust collected was found to be chiefly leather dust, mixed in some instances with rubber, talc, or chalk, and insignificant quantities of carborundum. Of the 73 air samples from which dust counts were made, only 7% showed counts ranging from 15 million to 20 million particles per cubic foot of air, while approximately 18% of the samples yielded counts of from 10 million to 15 million particles per cubic foot (*see Table 3*, Page 10).

Three sole and heel plants exhibited no important toxic hazard, while the operations at 11 miscellaneous leather goods plants were so varied that general conclusions cannot readily be summarized.

The safe operation of processes in these plants falls within the special fields of safety, engineering, and medicine. Safety measures, including training in safe methods of work, must be employed to prevent accidents. Where harmless substances cannot be substituted for harmful ones, labels on containers and drums should indicate the hazardous nature of the substance and workmen should be in-

TABLE 3
DUST CONCENTRATIONS AT SIMILAR TYPICAL OPERATIONS IN SHOE PLANTS

Operation	No. samples	No. employes exposed	Type of dust	No. of samples with concentrations 0-5 million	No. of samples with concentrations 5-10 million	No. of samples with concentrations 10-15 million	No. of samples with concentrations 15-20 million
Cutting dept.							
Cutting uppers	2	33	Leather	2	....	....	....
Roughing uppers and lining	5	9	Leather	1	4	....	....
Fitting dept.							
General air	2	100	Misc.	2	....	....	....
Lasting dept.							
General air	2	....	Misc.	2	....	....	....
Bottoming dept.							
Pounding and rasping uppers	8	16	Leather	....	6	2	....
Edge trimming	13	55	Leather	....	9	4	....
Heel trimming	8	19	Leather	....	6	1	1
Bottom sanding	8	16	Leather	....	6	2	....
Finishing dept.							
Heel scouring	6	16	Leather	1	5	....	....
Naumkeging	6	12	Leather	....	2	2	2
Blowing off shoes	3	1	Leather	....	1	1	1
Stock fitting							
Sanding outsoles	6	13	Leather	....	4	1	1
Sanding wood heels	3	6	Wood	...	3	....	....
Channeling insoles	1	1	Leather	....	1	....	....

structed as to dangers. Good housekeeping is essential and includes the care of spilled solutions and receptacles for soaked rags. Provision for showers, lockers, lunch rooms, and drinking facilities contributed to the maintenance of health in workers.

Engineering control measures involve periodical determination of the concentration of harmful substances escaping into the plant atmosphere under operating conditions, and the application of necessary corrective measures wherever they are indicated. Control measures include the segregation and complete enclosure of offending processes if at all practical, the employment of local exhaust ventilation and increased general ventilation, and other measures which the engineer may devise which will effectively control the hazard. There is no single measure applicable to all operations. A combination of measures usually must be employed to insure success. The entrapment by localized exhausts of harmful vapors and dusts at their sources of origin, and their disposal in such a manner as to prevent their dispersion is a practical method generally. Exhaust ducts, particularly those attached to spray booths, should be extended to the roof and not discharged outside of windows where the fumes may reenter the building. Important also is the periodic checking of exhaust systems for defects in order to maintain effective operation.

Good general ventilation, at all times, and adequate heating in cold weather should be provided.

Workers employed in hot atmospheres, such as drying rooms, should allow their bodies to cool gradually and, if possible, should take a shower before leaving the plant, particularly in cold weather. They should drink plenty of water, preferably with a little salt added to replace the salt lost in sweat. It is advisable to isolate drying processes so as not to expose other workers unnecessarily. Protective clothing, bathing, and changing to dry clothes also are recommended measures for counteracting ill effects from dampness and variations of temperature.

Medical supervision is an essential part of any health program. In the smaller plants, a trained nurse working under the direction of a part-time or consulting doctor is invaluable in caring for minor injuries, skin irritations, and emergency first aid work. Many infections and serious cases of occupational dermatoses and illnesses can be prevented by the early application of remedial measures. The measures designed for the protection of workers against specified occupational diseases is discussed in more detail in the report. The doctor should familiarize himself with the toxic effects of all harmful substances encountered in the plant under his supervision and with the special diagnostic methods for their detection. It is his responsibility to advise the plant management with respect to measures of personal protection to be applied to the workers.

SUMMARY

A report is presented of a survey of the physical environment of the leather industry, consisting of a total of 62 plants, including tanneries, shoe, and miscellaneous leather goods factories. A brief description of processes employed in making leather goods is given, and health hazards, either real or potential, incident to manufacturing processes are discussed.

It was found that the industry itself, by the introduction of new and improved methods, has eliminated many of the hazards formerly associated with older methods. The chief hazards remaining lie in the common use of a wide variety of chemical substances, including alkalies, acids, chromates, vegetable and synthetic tanning materials, oils, finishes, dyes, solvents and other materials which may cause skin affections and systemic poisoning among workers either handling these materials or exposed to the vapors of those which are volatile. In a number of plants the concentrations of volatile vapors in the plant atmosphere exceeded safe limits or even dangerous limits. This was especially true where benzol was encountered.

Skin infections following small abrasions and cuts are hazards particularly present in all tannery jobs. While the less dangerous pus-producing organisms usually are the causative agent the possibility of anthrax infection among workers handling hides must not be overlooked.

Many tannery workers, also, are exposed to varying temperatures and humidities, and to wetness, which may be influencing or contributing causes of illness.

Practical measures for the safe operation of plant processes are outlined.

TABLE 4 *(Part 1)*
SHOE MANUFACTURING PLANTS

Plant No.	Department	Operation	Solvents: No. samples	Solvents: Type solvent	Concentration, p.p.m.	Approximate No. employes exposed	Remarks
5	Fitting	Cementing	4	Petroleum naphtha	440	80	
	Stock fitting	Celluloid heel covering	1	Methyl Alcohol	6100	8	Heel covers soaked in open pans and placed on cloth to dry. No exhaust.
	Bottoming	Bottom cementing	1	Acetone	1320	4	
		Sole laying	1	Acetone	2200	4	Cement applied by automatic dispenser. No exhaust.
6	Fitting	Cementing for doubling					
		1st table	4	Petroleum naphtha	50–200	4	Cement applied by hand brushing. No exhaust system. Natural ventilation good except at 1st and 2nd tables, here a partition stops any cross ventilation.
		2nd table	4	Petroleum naphtha	200–400	4	
		extreme right of 1st table	6	Petroleum naphtha	400–1000	1	
		cementing throughout rest of room	6	Petroleum naphtha	20–80	15	
		Underlaying perforations	4	Butyl acetate	20–50	4	Felt pads soaked in butyl acetate used to moisten strips.
		Cementing linings	2	Petroleum naphtha	20–60	6	Cement applied by hand brushing. Ventilation good.
	Stock fitting	Cementing soles	6	Ether, alcohol, acetone, ethyl acetate	60–140	2	Cement applied by machine. No exhaust.
		Cementing soles	1	Petroleum naphtha	200	2	Cement applied by hand brushing.
		Celluloid heel covering	3	Alcohol, acetone	30–50	8	Heel covers soaked in crocks. Drained on cloth. Ventilation good.
		Cementing leather heel covers	3	Petroleum naphtha	100–150	2	Covers brushed with cement and allowed to dry in rack.
	Bottoming	Cementing uppers center of room	4	Acetone, alcohol, ethyl acetate	350–400	1	Machine cementing; concentration decreases rapidly a few feet from source.
		side of room	4	Acetone alcohol, ethyl acetate	150–200	1	

[4]Tables 4, 5 and 6, which are not printed here, are also on file at the American Documentation Institute, Offices of Science Service, 2101 Constitution Ave., Washington, D. C. Page 1 of Table 4 is printed here as a sample; the whole table consisting of 13 pp.