MICROSCOPE Vol 56:3 p.119-124 (2008)

Dr. George Sigerson, A Forgotten Pioneer in Microscopy for Occupational and Environmental Health, Part 2: Findings in Occupational Settings[1]

Andrew A. Havics
pH2, LLC*

KEYWORDS

Air pollution, historical microscopy, light microscopy, occupational health, environmental health, aerobiology, contagion, occupational exposure

ABSTRACT

Dr. George Sigerson produced two papers in 1870 on his microscopical researches in the year 1869. These were accomplished to provide a correlation between the particles in the air and the health of inhabitants. One is titled "Micro-Atmospheric Researches" and focused on ambient air in the cities and countryside as well as along the coast and on the sea. The other is titled "Further Researches on the Atmosphere" and focused on occupational airborne exposure and settled dust. The second paper provided a detailed look at a doctor's attempt to correlate health effects and breathing air in the workplace Similar to his first paper on "Micro-Atmospheric Researches", the second paper, "Further Researches on the Atmosphere" is unlike surrogate measures of exposure used prior to this time period because it more closely looked for the underlying cause using the light microscope as a guiding tool.

On January 24, 1870 and June 13, 1870, George Sigerson presented two papers (1-2) on his microscopical investigations into the correlation between particles in the air and environmental and occupational health. These papers were titled "Micro-Atmospheric Researches" and "Further Researches on the Atmosphere" and were read before the Royal Irish Academy. These papers were the compilation of his research from the previous year and were published in the Proceedings of the Royal Irish Academy, Volume I, Serial II, 1869-1870 Session, by the MH Gill in Dublin, printer to the Academy (Figure 1). George Sigerson, M.D., Ch.M., F.L.S. was a doctor of medicine (MD) with another degree (masters) in surgery (ChM) and was a Fellow of the Linean Society (3). In particular, Dr. Sigerson (1836-1925) was Ireland's first Neurosurgeon and a Senator (Figure 2). He also was an accomplished poet under the nom de plume Erionnach, MD, a political journalist, and became chair of botany and zoology of Catholic University (3); he perhaps better known for the Sigerson Cup, a championship for top division of university Gaelic football (soccer) in Ireland.

The first paper, Micro-Atmospheric Researches, was about particles collected in the ambient air along the coast of Ireland, in the cities or Ireland, and in the country. The second paper, Further Researches on the Atmosphere, was about the particulate in the air and settled dust in various industrial facilities.

As indicated in Part 1 (4), the Sigerson papers themselves are not unique in that others before Sigerson had correlated the health of workers (or rather the liv-

[1] Presented at Inter/Micro 1999
* 5250 E. US 36, Suite 830, Avon, IN 46123

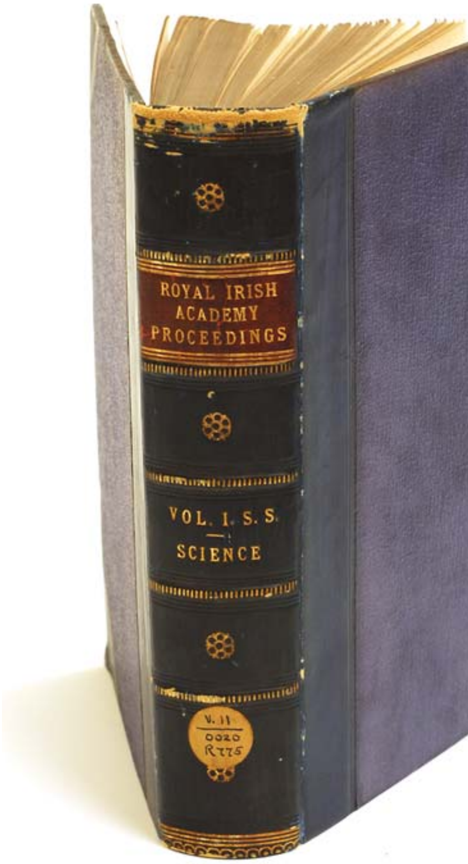

Figure 1: Author's copy of the "Proceedings of the Royal Irish Academy,*" Vol I, Serial II. 1870.*

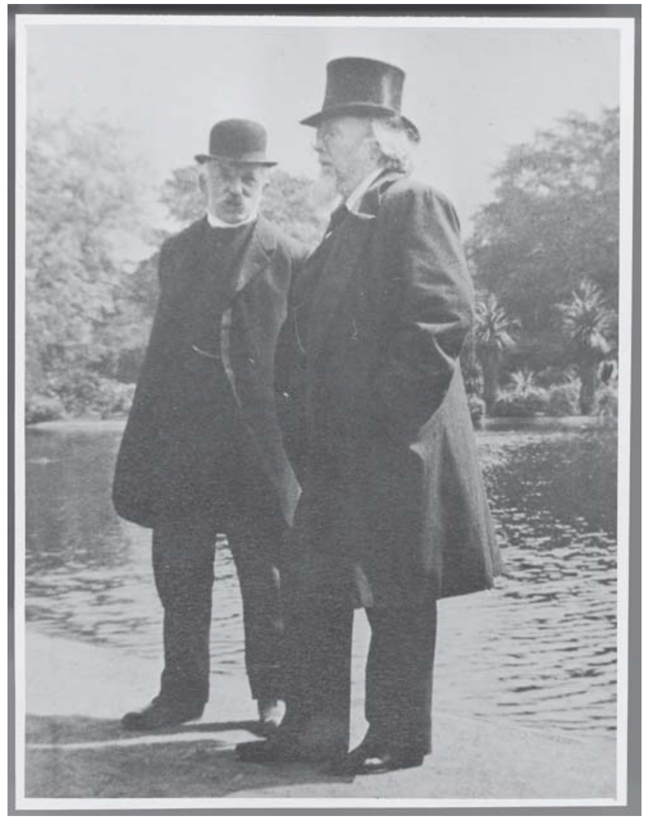

Figure 2: Photograph of Dr. George Sigerson (right) and D.J. O'Donoghue beside the pond in St. Stephen's Green, Dublin, when choosing a site for the Mangan Memorial (Image reproduced courtesy of the Irish Virtual Research Library and Archive, from the original in Special Collections, University College Dublin Library, Helen Solterer)

ing atmosphere) and disease. It also seems likely that Sigerson's work was prompted by a combination of his medical background and by England's factory acts on workplace health and safety conditions that began in 1833 and culminated in 1878 with the centralization of inspection of factories by creating a post for that purpose in London. This aside, Sigerson's second paper stands alone in its presentation of microscopy in the study of occupational settings. Sigerson's second paper is about findings from settled particulate on dry glass plates (although he apparently did try glycerine at some point) in the workplace air in a variety of workplaces. The sampling involved collection of,"sediment of the atmospheres, from ledges where it was deposited on a level with or above the height of man."

There were only three plates (VIII-X) covering six atmospheric environments: a shirt factory & iron factory (VIII), dissecting room and horse stable (IX), tobacco smoking and a tea taster's workplace (X). The text however also describes others - a threshing mill dust, an oat mill dust, scutchmill air, and printing office air.

The illustrations of shirt factory air particulate clearly indicate textile fibers including cotton, see the top half of Plate VIII. Noted in the text were "filaments of flax and cotton". The Doctor also discusses the adverse health effects indicating that for the less fortunate include cases of "phthisis" referred to in the modern era as tuberculosis. Ramazzini in 1713 (5) was the first to describe the asthma-like symptoms in flax workers which were caused by the inhalation of dust.

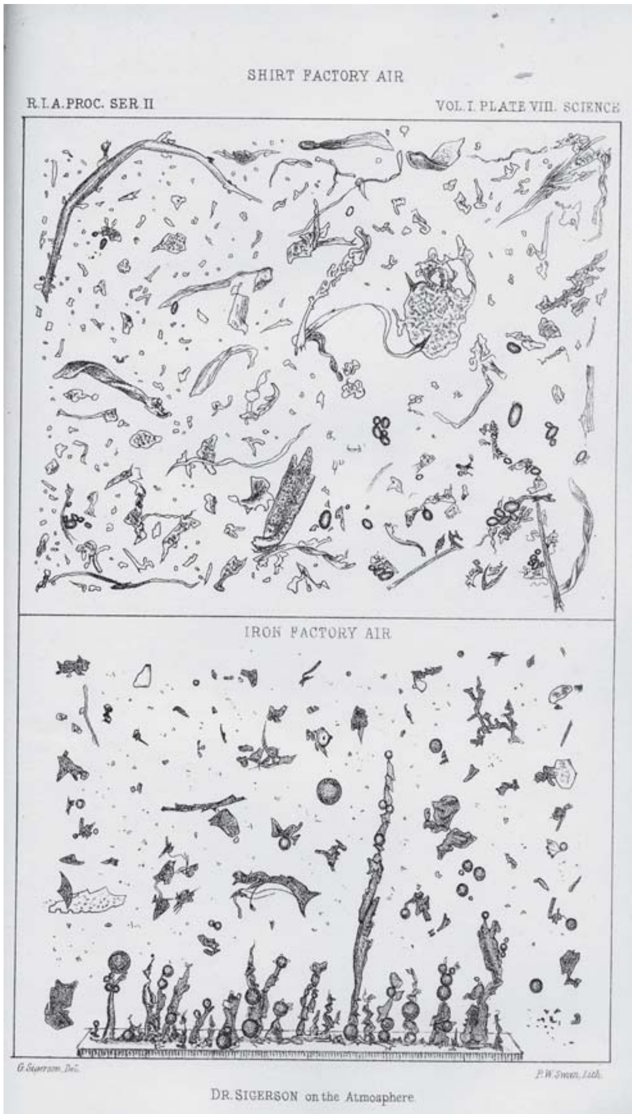

Plate VIII, shirt factory air & iron factory air.

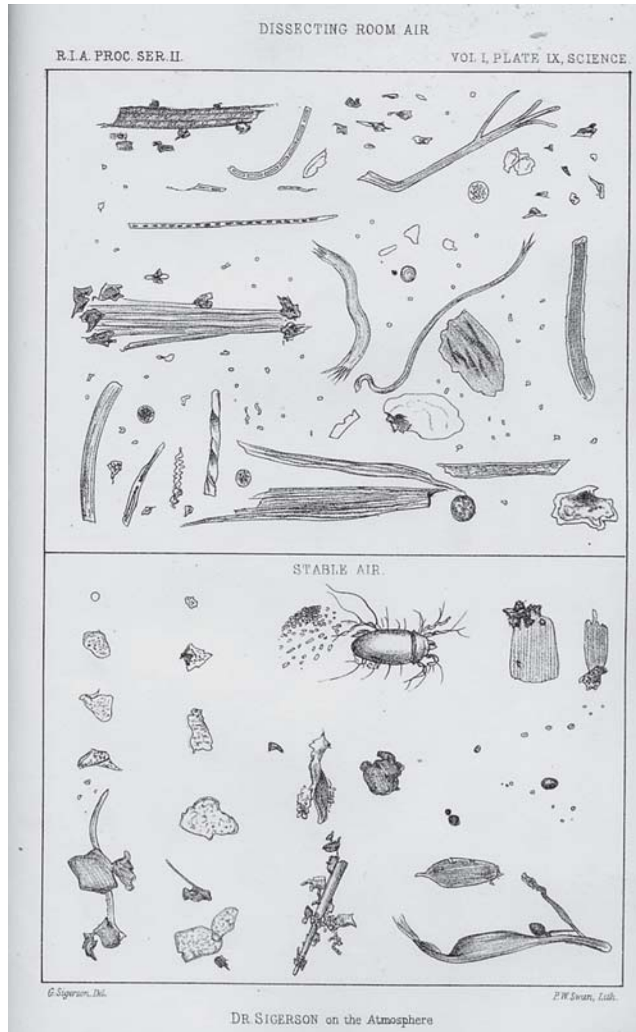

Plate IX, dissecting room air and (horse) stable air.

But the accounts of illness have continued into this century (6-15). One of the possible causes is from biological toxins in cotton (16).

Although no illustrations are provided, there is additional discussion on the health effects of working in a Scutch Mill, calling them "human slaughter houses, for,"the atmosphere is thick with dust, or 'stoor' of the very worst character." Scutching is the process of extracting the linen fibers from the stem of the flax. Originally it was accomplished by hand as the process wasn't mechanized during the second half of the 18th century (17). After the flax was pulled (cutting would result in shorter fibers) and retted (softened and partially rotted by immersion in still water) and dried, it was passed through the cogged rollers to break up the outer layer and the woody core. The first scutcher then guided the bundle of flax stems into the path of the spinning scutching blades to remove the unwanted material. The next scutcher repeated the process with the blades at a finer setting until all the unwanted material was removed and a bundle of flax fibers was left. Working in a scutch mill was a highly dangerous

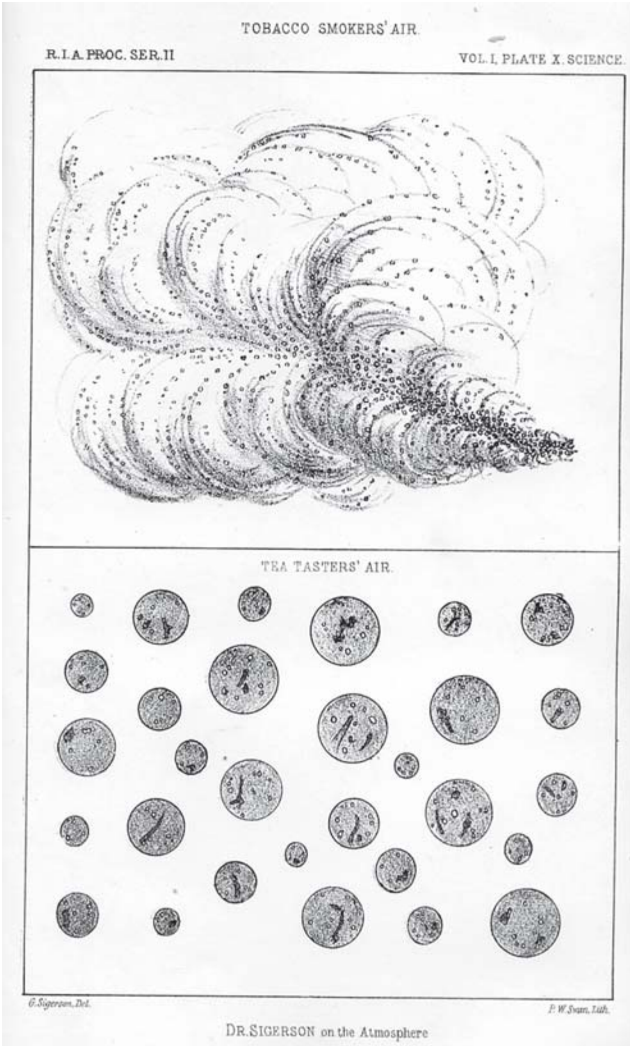

Plate X, tobacco smokers' air and tea tasters' air.

occupation. The workers were at risk from machinery that could not be stopped quickly in an emergency; the air was thick with dust that was unhealthy and there was an ever-present danger of fire (17). It is not surprising that Sigerson repeats a local saying that "scutchers die young." Sigerson also tells of the airborne aspects of threshing mill dust and oat mill dust, indicating contents including smut balls and spores, starch, acari or mites. Examples of these were also noted in Part 1 (4), and in the case of Farmers, the mold and actinomycete spores can result in Farmer's lung (18-20). And microscopic examination continues to be suggested for looking at the dust farmers are exposed to (19). This author's own work included looking at dust exposure to flax and buckwheat handling in the 1990s, although the concentrations were certainly much lower than historically cited here.

The second paper discusses in detail the findings from settled dust in the iron factory including carbon, glass, and iron hollow spheres (magnetic oxide). Illustrations are provided in Plate VIII. The iron spheres and pleospheres were sized from 8-85μm in diameter. The Dr. noted only healthy workers (except one having illness from an American brass factory). Although sidersosis [iron-based pneumoconiosis (built from the Greek roots meaning lung and dust)] has been observed in welders (21-24), the health or the workers observed may well have been an early observation of the healthy worker effect (25-26). A modern example of welding iron oxide fumes from the author, probably Fe_3O_4, is shown in Figure 3. Interest in iron oxides in airborne pollutant emission and exposure is still containing to this day (27-30).

The top of Plate IX illustrates findings from a dissecting room with the text suggesting that the air contained muscle tissue, epithelial cells, fat cells, and blood cells. A comparable blood aerosol from an operating room air sample collected by the author is shown in Figure 4, which is still a modern concern as a biological carrier of disease (31-32). The bottom of Plate IX illustrates findings from a horse stable with cotton fiber, horse hair, mold, and a few moth scales, etc. Although hairs, fibers and mold are common in air samples, moth scales (as noted in Part 1) are an uncommon but expected finding in air samples.

Sigerson follows these illustrations with Plate X, consisting of tobacco smoke on the top and tea tasters' air on the bottom, noting the nicotine globules in the smoke and globules of oil in the tea tasters. Smoking has been well recognized as a toxicologic threat (33-34). The health concerns are still present and tobacco residue is still found in some places in significant amounts, for example, see Figure 5 from a 1999 indoor air quality case.

Although tea tasting morbidity is not recognized, there is mixed evidence of tea toxicity (35). Details are also provided on the findings from printing office and the suggestion that antimony exposure resulted in nausea, and followup of chemical testing revealing antimony and iron (with a note regarding lead as well). Printing was and still is found to have metal hazards including lead and antimony (36-38). Sigerson goes on in this second paper to discuss in more detail musings on germ theory and its relation to health, in addition to that of operating rooms and bioaerols associated with cotton dust.

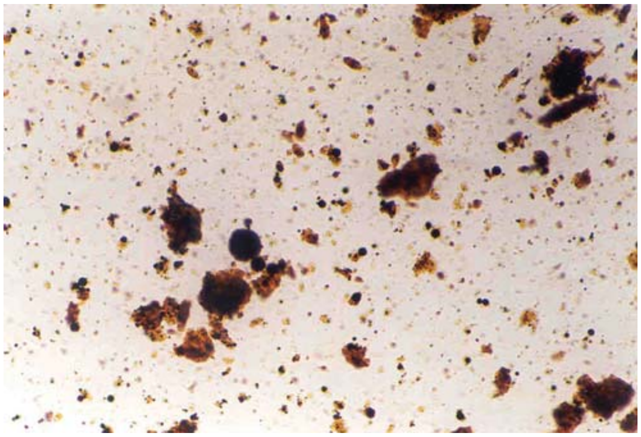

Figure 3: Iron oxide-based welding spheres collected by the author in 1994 during metal fume fever investigation.

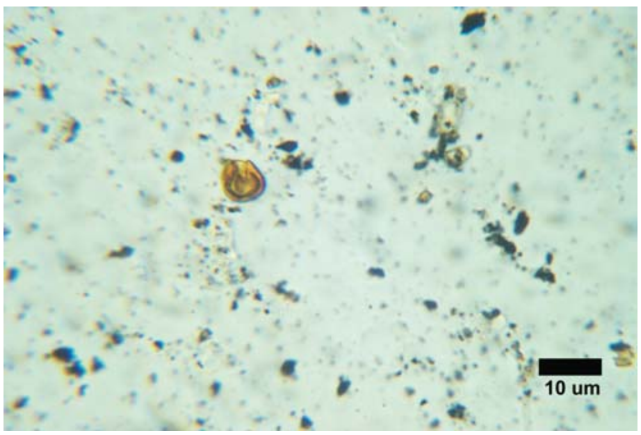

Figure 4: Blood and other aerosolized particles in an operating room in 2002 during an air quality complaint investigation.

In summary, in his second paper presented before the Royal Irish Academy by Dr. George Sigerson in 1870, he investigated by way of the microscope settled particulate on glass slides from ambient air in a number of locations in workplaces. He observed readily identifiable components as well as inferring the identity of others. From this he hypothesized, often correctly, that certain particles in the air would adversely affect the health of inhabitants and that the spread of disease could occur through some of the microorganisms present in the air. In this, he was ahead of his time by not just correlating surrogate bulk material with health outcomes but by trying to match specific underlying particles to health outcomes.

Figure 5: Heavy tobacco residue collected in an electrostatic precipitator (ESP) from air in a residence with a low air exchange rate.

ACKNOWLEDGMENTS

Special thanks again to Crit Stuart, Assistant Director for Information Access, at the Georgia Institute of Technology Library and Information Center, Atlanta, Georgia for allowing me to update my images of the plates from 1998 paper-based photocopies to 2006 digitally scanned images using the services of the library. I also thank the Irish Virtual Research Library and Archive for generous permission to allow publication of Dr. George Sigerson's photograph.

REFERENCES

1. Sigerson, George: Micro-Atmospheric Researches in *Proceedings of the Royal Irish Academy*, Vol I, Serial II. 1870. pp.13-21.

2. Sigerson, George: Further Researches on the Atmosphere in *Proceedings of the Royal Irish Academy*, Vol I, Serial II. 1870. pp.22-30.

3. Lyons, J.B.: George Sigerson, Charcot's Translator. *J Hist Neurosci* 6(1):5 60. 1997.

4. Havics, A.: Dr. George Sigerson, A Forgotten Pioneer in Microscopy for Occupational and Environmental Health, Part 1: Findings in Ambient Air. *Microscope* 54(2):83-91. 2006.

5. Ramazzini, B.: *De Morbis Artificium Diatriba*, 1713, translated by R. James, *A Treatise on the Diseases of Tradesmen*. London and York. 1746.

6. Roach, S.A. and R.S.F. Schilling: A Clinical and Environmental Study of Byssinosis in the Lancashire Cotton Industry. *Br J Ind Med* 17(1):1 9. 1960.

7. Gilson, J.C., et al.: Byssinosis, The Acute Effect on Ventilatory Capacity of Dusts in Cotton Ginneries, Cotton, Sisal, and Jute Mills. *Br J Ind Med* 18:9 18. 1962.

8. Bouhuys, A., et al: Byssinosis Prevalence and Flax Processing. *Br J Ind Med* 20:320 323. 1963.

9. Elwood, P.C., et al.: Byssinosis and Other Respiratory Symptoms in Flax Workers in Northerm Ireland. *Br J Ind Med* 22:27 37. 1965.

10. Elwood, P.C.: Respiratory Symptoms in Men Who Had Previously Worked in a Flax Mill In Northern Ireland. Br J Ind Med. 22:38 42. 1965.

11. Kilburn, K.H: Particles Causing Lung Disease. *Env Health Perspectives* 55:97 109. 1984.

12. Seboxa T. and Abebe Y: Byssinosis and tuberculosis among textile mill workers in Bahar Dar, Ethiopia. *Trop Geogr Med* 46(3):180-183. 1994.

13. Niven, R. McL., and C.A.C. Pickering: Byssinosis, a review. *Thorax* 51(6):632 637. 1996.

14. Mishra, Byssinosis among male textile workers in Pondicherry, A caseBcontrol study. *Nat Med J India* 16(2):70 73. 2003.

15. Kayumba, Akwilina, et al.: Acute respiratory symptoms among sisal workers in Tanzania. *Occ Med*, doi10.1093/occmed/kqm004, 2007.

16. Rylander, Ragnar: Endotoxin and occupational airway disease. *Curr Opin Allergy Clin Immunol* 6:62B66. 2006.

17. Ulster Historical Foundation: Gorticashel Flax-scutching Mill. http://www.uftm.org.uk/collections_and_research/folk_collections/rural_buildings/gorticas. Accessed 12/9/2007.

18. doPico, Guillermo, et al.: Health effects of occupational grain dust exposure, Am J Ind Med, 10, 298 299, 1986.

19. Lacey, John: Collection, detection, and identification of agents in farm dust implicated in respiratory disease. *Am J Ind Med* 10:311 313. 1986.

20. Terho, E.O.: Diagnostic criteria for farmer's lung disease. *Am J Ind Med* 10:329. 1986.

21. Doherty, M.J., et al: Total body iron overload in welder's siderosis. *Occup Environ Med* 61:82 85. 2004.

22. Stanescu, Dan C., et al.: Aspects of Pulmonary Mechanics in Arc Welders' Siderosis. *Br J Ind Med* 24:143 147. 1967.

23. Kober, George A.: Occupation in Relation to Tuberculosis. *Public Health Rpt* 35(13):751 770. 1920.

24. Anon, Health of Arc Welders in Steel Ship Construction, A Review Health of Arc Welders in Steel Ship Construction, A Review, 63, 5, 488 489, 1948.

25. Radon, Katja, et al.: Healthy worker effect in cohort studies of chronic broinchitis. *Scand J Work Environ Health* 28(5):328 332. 2002.

26. Watsubo,Y., M. Matrat, P. Brochard, J. Ameille, D. Choudat, F. Conso, D. Coulondre, R. Garnier, C. Hubert, F. Lauzier, M.C. Romano and J.C. Pairon: Healthy worker effect and changes in respiratory symptoms and lung function in hairdressing apprentices. *Occup Environ Med* 60:831-840: 2003.

27. Khosa, J., et al.: Results from preliminary investigation of particulate emission. *Trans Inst Min Metall C* 112:C25 C32. 2003.

28. Ortner, Hugo M.: Sampling and characterization of individual particles in occupational health studies. *JEM* 1:273 283. 1999.

29. Choel, Single particle analysis of atmospheric aerosols at Cape Gris Nez, English Channel, Influence of steel works on iron. *Atmos Environ* 41:2820B2830. 2007.

30. Zhao, Yongchun, et al.: Mineralogy, Chem Comp, and Microstructure of Ferrospheres in Fly Ashes from Coal Combustion. *Energy & Fuels* 20:1490 1497. 2006.

31. Heinsohn, Patricia and Don L. Jewett: Exposure to Blood Containing Aerosols in the Operating Room, A Preliminary Study. *AIHA J* 54(8):446 453. 1993.

32. Jewett, Don, et al: Blood Contaning Aerosols Generated by Surgical Techniques A Possible Infectious Hazard. *AIHA J* 53(4):228 231. 1992.

33. Smith, C.J., and C. Hansch: The relative toxicity of compounds in mainstream cigarette smoke condensate. *Food Chem Toxicol*. 38:637 646. 2000.

34. Hecht, Stephen S.: Tobacco Smoke Carcinogens and Lung Cancer. *J Natl Cancer Inst* 91(14):1194 1210. 1999.

35. Wang, Chung S., and Zhi-Yuan Wang: Tea and Cancer. J Natl Cancer Inst. 85:1038 1049. 1993.

36. Copper, David, et al: Pneumoconiosis Among Workers in an Antimony Industry. *Am J Roentology Radium Therapy Nuc Med* 103(3):495 508. 1968.

37. Radaydeh, : Testing the Awareness of Hazardous Nature of Printmaking Materials and Printmaking Students in Traditional and Non-Toxic Printmaking Programs. *J Health Sci* 50(6):570 575. 2004.

38. Oke, S.A., et al: Occupational Lead Exposure in Printing Presses, An Analytical Approach. *Pacific J Sci Tech* 9(1):263 271. 2008.