

ISO/TR 21275:2017-02 (E)

Rubber - Comprehensive review of the composition and nature of process fumes in the rubber industry

| Contents | | Page |
|--------------------|---|-------------|
| Foreword | | v |
| Introduction | | vi |
| 1 | Scope | 1 |
| 2 | Normative references | 1 |
| 3 | Terms and definitions | 1 |
| 4 | Overview of the rubber industry | 8 |
| 4.1 | General | 8 |
| 4.2 | Rubber component production processes | 8 |
| 4.3 | Generic rubber types | 11 |
| 4.4 | Rubber chemicals and additives | 12 |
| 4.5 | Mechanistic chemistry of rubber vulcanization | 13 |
| 4.5.1 | Generality | 13 |
| 4.5.2 | Sulfur-accelerated cure systems | 13 |
| 4.5.3 | Peroxide-based cure systems | 14 |
| 4.5.4 | Metal oxides | 14 |
| 4.5.5 | Other vulcanizing systems | 14 |
| 4.6 | Effect of elevated temperature on rubbery polymers and rubber additives | 15 |
| 5 | Definition of rubber fumes | 15 |
| 6 | Nature and composition of rubber fumes | 16 |
| 6.1 | General | 16 |
| 6.2 | Key components of rubber fumes and their origin | 16 |
| 6.3 | Trapping and analysis of rubber fumes | 17 |
| 6.3.1 | General | 17 |
| 6.3.2 | Characterization studies carried out in factory environments | 17 |
| 6.3.3 | Characterization studies carried out under laboratory conditions | 18 |
| 6.4 | Changes in rubber technology that have influenced the nature and composition of rubber fumes and improved the protection of workers in the industry | 19 |
| 6.4.1 | General | 19 |
| 6.4.2 | Overall trend in rubber workers' exposure to total rubber fumes | 19 |
| 6.4.3 | Polyaromatic hydrocarbons | 19 |
| 6.4.4 | Nitrosamines | 19 |
| 6.4.5 | Silane coupling agents and resorcinol steel cord coating agent | 19 |
| 7 | Factors affecting the variability of rubber fumes | 19 |
| 7.1 | General | 19 |
| 7.2 | Influence of the rubber compound formulation on the composition of rubber fumes | 20 |
| 7.3 | Influence of different manufacturing processes on rubber fumes | 20 |
| 7.4 | Influence of different processing temperatures on the composition of rubber fumes | 21 |
| 8 | Review of literature on the composition and nature of rubber process fumes | 22 |
| 8.1 | Comprehensive literature search | 22 |
| 8.1.1 | General | 22 |
| 8.1.2 | Rubber fumes data obtained from factory atmospheres | 22 |
| 8.1.3 | Rubber fumes data obtained by laboratory studies | 32 |

| | | |
|-------|--|----|
| 8.1.4 | Research on sampling and analysis techniques for rubber fumes | 36 |
| 8.1.5 | Influence of rubber additives on the composition of rubber fumes | 38 |
| 8.1.6 | Work carried out at Rapra Technology Ltd | 40 |
| 8.2 | Other sources of information | 41 |
| 8.2.1 | General | 41 |
| 8.2.2 | Search strategy for external databases | 42 |
| 8.2.3 | Chemical abstracts results | 42 |
| 8.2.4 | General POLLUAB and NTSI database results | 43 |
| 8.2.5 | Search of industry-relevant publications, government publications and relevant website.. | 43 |
| 9 | Summary of the findings of the literature review | 44 |
| 10 | Conclusions | 45 |
| | Annex A (informative) Abbreviated terms | 47 |
| | Bibliography | 49 |