

# ISO/TR 21275:2017-02 (E)

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

---

<b>Contents</b>		<b>Page</b>
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	Summaryofthefindingoftheliteraturereview .....	44
10	Conclusions .....	45
	Annex A (informative) Abbreviated terms .....	47
	Bibliography .....	49