Health Effects of Short-term Volcanic SO_2 Exposure and Recommended Actions

The colors in the table indicate the average concentration of SO_2 for 10-15 minutes. The health effects depend both on the time of SO_2 exposure and SO_2 concentration. Health effect limits are defined as the average concentration of SO_2 of 350 $\mu g/m^3$ for one hour or 125 $\mu g/m^3$ for 24 hours.

Concentration of SO_2		Air quality description	Recommended actions	
$\mu g/m^3$	ppm		All children. Sensitive Groups *	Healthy individuals
		Good		
0-350	**0-0,1**	Poses little or no health risk.	Can experience mild respiratory symptoms.	No health effects expected.
		Moderate		
350-600	**0,1-0,2**	May cause respiratory symptoms in individuals with underlying diseases.	Caution advised. Follow SO_2 measurements closely. Avoid outdoor activities. Shut down air conditioning.	Health effects unlikely. Shut down air conditioning.
		Unhealthy for sensitive individuals		
600-2.600	**0,2-1,0**	Individuals with underlying diseases likely to experience respiratory symptoms. Health effects unlikely in healthy individuals.	Avoid outdoor activities. Shut down air conditioning.	Health effects not expected. Heavy outdoor activities not advised.
		Unhealthy		
2.600-9.000	**1,0-3,0**	Everyone may experience respiratory symptoms especially individuals with underlying diseases.	Remain indoors and close the windows. Shut down air conditioning.	Avoid outdoor activities. Remaining indoors advised. Close the windows and shut down air conditioning.
2.600	**1,0**	Working limits for 15 minutes	All work forbidden except with use of gas masks.	All work forbidden except with use of gas masks.
		Very unhealthy		
9.000-14.000	**3,0-5,0**	Everyone may experience more severe respiratory symptoms.	Remain indoors and close the windows. Shut down air conditioning. Follow closely official advises.	Remain indoors and close the windows. Shut down air conditioning. Follow closely official advises.
		Hazardous		
> 14.000	**>5,0**	Serious respiratory symptoms expected.	Remain indoors and close the windows. Shut down air conditioning. Follow closely official advises.	Remain indoors and close the windows. Shut down air conditioning. Follow closely official advises.

* All children. Adults with pre-existing bronchial asthma (history of wheezing or confirmed asthma), bronchitis, emphysema and heart diseases. These recommendations also apply to pregnant women.

Working limits:

If the average SO_2 concentration exceeds 1.300 µg/m^3 for 8 hours, the working period has to be shortened proportionally to the SO_2 concentration or appropriate gas masks have to be used.

It the average SO_2 concentration exceeds 2.600 µg/m^3 for 15 minutes, all work has to be stopped or appropriate gas masks have to be used.

See http://www.vinnueftirlit.is/um-vinnueftirlitid/frettir/nr/1170

General recommendations:

- Individuals with pre-existing pulmonary and heart diseases are encouraged to have their medications readily available.
- Breathe with your nose as much as possible and avoid physical exercise outdoors during heavy pollution as this will reduce the amount of SO_2 reaching the lungs.
- Remaining indoors with windows closed and air conditioning shut down provides a significant protection against the pollution.

Further measures:

During heavy SO_2 pollution and if you experience respiratory difficulties, even indoors, you can take the following measures to reduce the concentration of SO_2 in the air by preparing a simple air cleaning device.

1. Take 5 grams of ordinary baking soda and dilute it in 1 liter of water.
2. Soak a piece of cloth, e.g. a dish towel, a thin towel or an old fashioned flat cloth diaper in the solution.
3. Wring most of the water from the cloth so that no water leaks from it.
4. Fasten the damp cloth on to some sort of frame, e.g. a drying rack, and fasten it on all sides of the rack, for instance by means of clothespins.
5. Place the rack in the room where the air is to be cleaned.
6. The cloth must be kept damp if it is to continue to work as intended and to keep its moisture you should spray it with water, e.g. from a flower spray bottle.
7. In order to increase the effect let a table top fan blow air on the cloth**. NB!** The fan is an electric tool, so take care that moisture from the cloth or the spray bottle does not reach the fan. The fan must be situated at a safe distance from the cloth, no closer than about two meters. By no means spread the cloth over the fan itself.
8. If a fan is not available the cloth will still be effective, particularly if placed close to wall heaters since there is more air flow in the proximity of heaters than in other places in the home. **NB**! There is no need to spread the cloth over the heater, it is sufficient to place it on a rack by the side of it. Be careful with electric heaters as the air flow around them must not be restricted and they must never be covered.

9. If a high concentration of SO_2 continues for a long period the cloth must be rinsed in running water two times a day and placed in the baking soda solution.

High concentration of SO_2 outdoors

If people must stay outdoors during a high concentration of SO_2 that causes respiratory difficulties, it is helpful to hold a damp cloth to your mouth and nose as this will reduce the amount of SO_2 in the air you inhale. A cloth soaked in a baking soda solution, as described above, is still more effective, however. Please note that water makes the cloth less permeable so that breathing through it is more difficult. This can prove difficult or even dangerous for weak individuals.

You can also use a traditional dust mask that can be obtained in hardware stores and soak it in baking soda solution. Dust masks, however, are so impermeable that the added water increases their resistance and makes them hard to breathe through. The mask must therefore be fully dried before use, which takes about 24 hours.

ATTENTION: Damp cloths and dust masks that have been soaked in baking soda solution only work for a short while (several minutes) and are not nearly as effective as gas masks. This is therefore not a long lasting measure and cannot at all be used very close to the eruption site. In that area, the use of gas masks is the only effective way of reducing SO_2 in inhaled air. Gas masks, however, are not widely available and their use is not advised unless in circumstances where the SO_2 concentration is very high as in the proximity of an eruption site, and according to official recommendations.

The Chief Epidemiologist for Iceland, the Environmental Agency, the Administration of Occupational Safety and Health and the Civil Protection. October 2014.