Committee for Risk Assessment
(RAC)

Opinion

on the risk assessment contained
in the RIVM Letter report 601352002/2013
"Risk assessment of an increased concentration limit
of benzene in natural gas"

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OPINION OF THE COMMITTEE FOR RISK ASSESSMENT ON THE RISK ASSESSMENT CONTAINED IN THE RIVM REPORT "RISK ASSESSMENT OF AN INCREASED CONCENTRATION LIMIT OF BENZENE IN NATURAL GAS"

Pursuant to Article 77(3)(c) of Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (the REACH Regulation), the Committee for Risk Assessment (RAC) has adopted an opinion on the consumer-related risk assessment contained in the RIVM Letter report 601352002/2013 "Risk assessment of an increased concentration limit of benzene in natural gas".

I PROCESS FOR ADOPTION OF THE OPINION

Following a request from the European Commission, in the mandate of 15 July 2014 attached as Annex 2, the Executive Director of ECHA asked RAC to draw up an opinion on the ***consumer-related*** risk assessment contained in the RIVM Letter report 601352002/2013 "*Risk assessment of an increased concentration limit of benzene in natural gas*" (see Annex 1). In particular, the opinion should be developed as follows:

a) Evaluate the exposure information contained in the RIVM report and in particular the risk assessment performed on consumers exposed to benzene contained in natural gas. The analysis should only focus on the exposure scenario analysed in the report for cooking and heating, not on accidental leakage of the natural gas;

b) Express ***whether RAC can confirm the conclusions of the RIVM report*** that consumer exposure to benzene present in natural gas at a concentration greater than 0.1% (w/w) but below 0.1% (v/v) during regular use of natural gas as fuel for cooking and heating does not represent a risk for consumers that is not adequately controlled.

RAC appointed Bogusław Barański as rapporteur on **6 October** 2014. The draft opinion prepared by the rapporteur was submitted for consultation by RAC in October 2014.

The RAC opinion was adopted **by consensus** on **28 November 2014.**

II OPINION OF RAC

RAC has formulated an opinion on the risk assessment contained in the RIVM Report "*Risk assessment of an increased concentration limit of benzene in natural gas*"

Based on the assumptions and conditions set out in the RIVM report, RAC is of the opinion that consumer exposure to benzene present in natural gas at a concentration greater than 0.1% (w/w) but below 0.1% (v/v) during regular use of natural gas as fuel for cooking and heating does not represent a risk for consumers that is not adequately controlled. However, this opinion does not cover the consumer exposure and risk arising from exposure scenarios other than those described in the RIVM report. RAC therefore cannot confirm that for any conditions or equipment other than those described in the RIVM report the risks for consumers are adequately controlled.

III SCIENTIFIC GROUNDS FOR THE OPINION

Summary of the information and conclusions contained in the RIVM report

Benzene is a volatile liquid that is carcinogenic.

The RIVM report notes that most benzene concentrations in natural gas are below the limit of 0.1% (w/w). Occasionally, benzene concentrations exceed this limit with concentrations of up to 0.42 % (w/w). This may occur for natural gas from small fields. However, this natural gas with a higher concentration of benzene is subsequently diluted with natural gas from other sources; this means that consumer exposure to high benzene content in natural gas is limited due to dilution. In fact, it is assessed by RIVM that a benzene concentration of 0.1% (w/w) in natural gas overall reflects a worst case situation for Dutch consumers. As to the situation for consumers in other EU Member States, it is stated in the report that this worst case assumption would also hold for natural gas transported outside the Netherlands, as it may be diluted even further during transport and mixed with other sources.

The use of benzene is restricted to prevent risks to human health. In Annex XVII to REACH the presence of benzene in natural gas is indicated as a mass fraction (0.1 percent equal to 1 g benzene in 1000 g of natural gas). It is proposed to change this limit to the same unit as set for gases in other European legal frameworks, where they are indicated as a volume fraction (0.1 percent equal to 1 litre of benzene in 1000 litres of natural gas). According to RIVM, it is unlikely that this conversion would cause a health hazard in typical situations of human exposure to benzene via natural gas, which is demonstrated in their report for various exposure scenarios, including the use of natural gas in the kitchen and for home heating. Based on these scenarios, the RIVM Letter report concludes that exposure to benzene remained below the safety limit.

In particular, it is concluded that consumer exposure to benzene present in natural gas at a concentration greater than 0.1% (w/w) but below 0.1% (v/v) during regular use of natural gas as fuel for cooking and heating does not represent a risk for consumers that is not adequately controlled.

Evaluation of the consumer-related exposure scenarios for cooking and heating employed in the RIVM report

Two scenarios of exposure to benzene of consumers were considered:

1) as a result of cooking
2) as a result of heating

Exposure during cooking

During cooking with natural gas, the consumer can be exposed to benzene in the gas. The exposure will occur when unburned gas is released into the kitchen during the few seconds from when the gas tap is opened until ignition of the gas. Once the gas is burning, benzene is also burned and the consumer is no longer exposed. Therefore the time between the start of gas release in a cooker and ignition determines the volume of gas released to the kitchen space. In the case of a cooker with an electronic ignition, the flame usually burns after the third spark, thus after 3 seconds. In case of cookers (cooking rings) without electronic ignition, the time needed by the consumer to ignite the gas with matches or a candle lighter will be longer, but any duration above 5 seconds will be avoided, in order to prevent inducing a burst of flame. In this case, therefore, the time of gas release before ignition was taken as 5 seconds. Based on the capacity of a standard gas cooking ring in the Netherlands, which is most probably similar to that in other EU countries, it was estimated that after opening gas supply of the cooker a gas ring will release from 4.72×10^{-6} to 1.57×10^{-5} m^3 (0.00472L - 0.0157L) natural gas per second during 1 second.

For an estimation of the total amount of gas released from a cooker before ignition, it was assumed that the consumer will cook a dinner simultaneously using all four rings for 60 minutes and in addition, use one ring 6 times a day for the preparation of boiling water to make tea. The room volume of the kitchen is assumed to be $15m^3$, and the air exchange rate is 2.5 times/h. A detailed description of this scenario is submitted as appendix 2 of the RIVM report together with calculations of the resulting exposure levels for gas containing benzene at concentrations of 0.1% (w/w) and 0.1% (v/v).

According to appendix 2 of the RIVM Letter report, the estimated mean benzene concentrations in air in the kitchen due to natural gas containing 0.1% (v/v) or 0.1% (w/w) benzene are as follows:

Concentration benzene in natural Gas	**Exposure Time**	**Mean concentration benzene in air (ug/m^3)**	
		Cooking	**Tea**
0.1% (v/v)	15 min	33.7	12.9
	60 min	16.7	-
0.1% (w/w)	15 min	8.0	3.1
	60 min	4.0	-

The estimated mean benzene concentrations in air in the model kitchen due to natural gas containing 0.1% (v/v) or 0.1% (w/w) benzene were calculated with ConsExpo 4.1. As the values of the parameters used in the calculation by RIVM deviate from those in previous RAC opinions, which used 20 m^3 for the kitchen volume ($15m^3$ used by RIVM) and a ventilation rate of 2 times/h (2.5 times/h used by RIVM) (based on RIVM report 320104002/2006), it was checked whether the latter would lead to substantially different mean benzene concentration in air on the basis of the same calculations (see below). It was concluded that this was not the case.

Concentration benzene in natural gas	Exposure time	Mean concentration benzene in air (ug/m³) Cooking	Tea
0.1% (v/v)	15 min	26.0	10.0
	60 min	14.3	-
0.1% (w/w)	15 min	6.2	2.4
	60 min	3.4	-

Exposure during heating

In the Netherlands, as well as in other EU countries, the vast majority of domestic homes are heated with central-heating boilers. The techniques involving this type of heating are well developed. The flame of the central-heating boiler can only be ignited electronically. The burner of the boiler is sealed-off from the outside in such a way that no natural gas can escape. It is therefore concluded that there will be no exposure from central-heated boilers during ignition of the flame and during daily operation of the boiler.

Besides central-heating boilers, domestic homes are sometimes also heated with gas heaters. During the ignition of the flame, the consumer may be exposed to gas, but this will generally only occur at the start of season when heating is needed. During the rest of the heating season the heater will burn on the pilot flame and no gas will escape without burning. In case the pilot flame dies, and the gas heater has not got a thermal safety device, considerable volumes of natural gas may be released. In such an event, the risks of acute gas poisoning or explosion caused by the natural gas, considerably outweighs the acute risk of exposure to benzene. Additionally, tetrahydrothiophene (THT) used to odorize gas will warn the consumer that gas is leaking, which will trigger action. This situation is considered as accidental and therefore outside the scope of the present evaluation.

Characterisation of Risk for Consumers

Benzene is irritating to skin, eyes and respiratory tract and can cause chemical burns, collapse, haemorrhagic lungs, pulmonary oedema, bronchitis and pneumonia by acute dermal or inhalation exposure. It has been documented that in humans, an inhalation exposure to 0.16-0.48 g/m^3 for 6 hours can result in headache and lassitude, while 0.08 g/m^3 gave no acute effects.

The main target organs following repeated exposure are cells of the haematopoietic system (i.e. bone marrow, spleen, thymus, lymph nodes). Chronic exposure can result in bone marrow depression, anaemia and thrombocytopenia. Carcinogenicity was shown in inhalation studies with mice and rats with tumours predominant in the haematopoietic system, particularly lymphomas in mice and leukaemia in rats. Human epidemiological data have shown a causal relationship between benzene exposure and acute and chronic leukaemia.

Based on analyses reported by WHO and Wong and Raabe (1995), the European Commission has defined a limit range of 0.2-20 µg/m^3 benzene associated with an excess risk of leukaemia of 1 in a million (EC, 1999b). A limit value of 5 µg/m^3, with an average measuring period of one year, was determined to be protective and feasible (EC, 2008c). The current (non-legally binding) target limit in the Netherlands, as determined by the Dutch Ministry of Infrastructure and Environment, is 1 µg/m^3 (de Jong and Janssen, 2011).

Out of the two exposure scenarios considered for consumers, which are exposure during cooking (cooking dinner and preparing tea) and due to heating, only exposures during cooking are relevant for the risk assessment of benzene for consumers. The estimated exposure to benzene in natural gas during cooking was highest during cooking dinner. Estimated concentrations of benzene (0.1% (v/v) and 0.1% (w/w) in natural gas) during 60 min of cooking were 16.7 µg/m^3 and 4.2 µg/m^3 respectively. When considering a short peak concentration during 15 min, concentrations were 33.7 µg/m^3 (0.1% v/v) and 8.0 µg/m^3 (0.1% w/w).

Since acute effects are expected to occur at levels above 80 mg/m^3, no acute effects are expected from exposure to the estimated peak benzene concentrations. Therefore, 0.1% (v/v) benzene in natural gas does not lead to an unacceptable acute risk during cooking.

The currently estimated exposure levels are defined as concentrations in the air to which humans can be exposed by inhalation. However, for risk assessment of the carcinogenic effects, the absorbed dose of benzene is of higher importance.

The estimated dose (based on 0.1% (v/v)) of benzene absorbed during 60 minutes of exposure to 16.7 µg/m^3 corresponds to a 24 hour exposure to 0.7 µg/m3. This is lower than the dose that would be absorbed when exposed for 24 hour exposure to the limit of 5 µg/m^3.

The estimated dose (based on 0.1% (v/v)) absorbed during 60 minutes of cooking plus six times boiling water for tea during 15 minutes corresponds to a 24 h exposure to 1.5 µg/m^3. This is also below the dose that would be absorbed when exposed to 24 h exposure to the limit of 5 µg/m^3. Therefore, there is no unacceptable risk due to benzene exposure during cooking.

Finally, RAC would like to raise the following points:

- Some of the parameters used by RIVM are not those which have been previously used by RAC: ECHA guidance as applied by RAC has a default room size of 20 m^3 (the RIVM report uses a room volume of 15 m^3); in previous opinions, RAC has used 2 air exchanges per hour and 0.2 where no air exchange occurs (the ventilation rate used in the report is 2.5 air exchanges per hour). Otherwise ECHA guidance indicates for consumers an inhalation rate of 20 m^3 per day, where 32.9 m^3 per day are used in the RIVM report. The effect of the parameters used in ECHA guidance has not been fully evaluated, as they have not been part of the RIVM Letter report. However, as indicated in the tables above, they do not appear to make a significant difference to the estimated benzene concentrations in air.
- Any considerations referring to information and conditions which are not described in the RIVM Letter report are outside the mandate to RAC, as this only required an assessment of the information and risk assessment provided in the RIVM report.

Overall conclusion

After reviewing the document entitled "*Risk assessment of an increased concentration limit of benzene in natural gas*" prepared by the National Institute for Public Health and the Environment in the Netherlands (RIVM), RAC confirms the conclusions of the RIVM letter report that, on the basis of the conditions set out in that report, **consumer exposure to benzene present in natural gas at a concentration greater than 0.1% (w/w) but below 0.1% (v/v) during regular use of natural gas as fuel for cooking and heating does not represent a risk for consumers that is not adequately controlled.**

ANNEXES

Annex 1 RIVM Letter report 601352002/2013 "Risk assessment of an increased concentration limit of benzene in natural gas"

Annex 2 Request from the Executive Director of ECHA to RAC of 15 July 2014 (I(2014)0217) – 'the mandate'.

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