

SGS-9-06

Comparison of Permeation Standards Among HySAFE, SAE and Japanese Regulations and Proposal to GTR

JASIC

1) Comparison of Permeation Standards Among HySAFE, SAE and Japanese Regulations

[Purpose of Review]

Since the definition of permeation amount varies among HySAFE, SAE, and Japanese regulations, it is difficult to clearly compare allowable permeation amount under these standards. The purpose of this review is to unify the definition and compare permeation amount among these standards.

Definition of permeation amount among HySAFE, SAE, and Japanese regulations

Current Japanese regulation: Prescribes that permeation rate for new containers be 5 Ncc/L/hr. As temperature, we set it at 15°C. Further, we reflected the opinions of container manufacturers and automakers and considered the actual performance of currently used containers.

SAE: Prescribes that the allowable permeation amount of the vehicle be 150 Ncc/min. Considers an external temperature of 55°C taking EOL into account. Prescribes garage volumes according to the sizes of the vehicle.

HySAFE: Prescribes that the allowable permeation rate of the container be 6 Ncc/L/hr. Considers an external temperature of 55°C taking EOL into account. Prescribes the sizes of tank and garage for three sizes of vehicles.

	Allowable Permeation Rate (Ncc/L/hr) [New at 15°C]	Allowable Permeation Rate (Ncc/L/hr) [New at 55°C]	Allowable Permeation Rate (Ncc/L/hr) [EOL at 55°C]	Storage Volume (L)	Allowable Permeation (Ncc/min)	Ventilation rate (ac/hr)	Garage Volume (m3)	Maximum Hydrogen Concentration (%)
Japanese regulations	5	-	—	360	30	0.18	36.4	0.028
SAE					150	0.03	30.4	1
HySAFE (Large Car)	6	28.2	56.4	249	232	0.03	46	1
HySAFE (Small Car)	6.8	31.96	63.92	149	157	0.03	31	1
HySAFE (Mini Car)	7.9	37.13	74.26	75	91	0.03	18	1

2) Examination of Permeation Rate for Containers Under SAE Standard

* Here we calculated the permeation rate for containers under SAE from permeation amount for vehicles (150 cc/min). Based on SAE's concept of vehicle permeation amount and garage volume, we calculated permeation rate for containers using vehicle sizes, temperature factor, and aging factor of HySAFE.

- Vehicle size (HySAFE values)

Large Car: 5.2 m*2.2 m*1.5 m (Storage Volume=249 L)

Small Car: 3.6 m*1.9 m*1.4 m (Storage Volume=149 L)

Mini Car: 2.7 m*1.8 m*1.5 m (Storage volume=91 L)

- Vehicle permeation amount (SAE base)

Allowable Permeation (Ncc/min)= 150*(Vehicle Length+1)*(Vehicle Width +1)*(Vehicle height +0.5)/30.4

- Garage volume (SAE base)

Garage Volume (m3)= (Vehicle Length+1)*(Vehicle Width +1)*(Vehicle height +0.5)

- Temperature factor and aging factor (HySAFE values)

Aging Factor=1/2 (from EOL to New)

Temperature Factor=1/4.7 (from 55°C to 15°C)

[Results of calculation of permeation rates for containers from permeation amounts for vehicles under SAE standard]

Permeation rate for new containers under SAE standard calculated from permeation amount for vehicles (150 cc/min) is 5.2 Ncc/L/hr.

	Allowable Permeation Rate (Ncc/L/hr) [New at 15°C]	Allowable Permeation Rate (Ncc/L/hr) [New at 55°C]	Allowable Permeation Rate (Ncc/L/hr) [EOL at 55°C]	Storage Volume (L)	Allowable Permeation (Ncc/min)	Ventilation rate (ac/hr)	Garage Volume (m3)	Maximum Hydrogen Concentration (%)
SAE (Base)	5.2	24.5	49	184	150	0.03	30.4	1
SAE (Large Car)	5.02	24	47	249	195	0.03	40	1
SAE (Small Car)	5.4	25	50	149	125	0.03	25	1
SAE (Mini Car)	8.7	41	82	75	102	0.03	21	1
SAE(360L container)	4.9	23.3	45.7	360	274	0.03	55.6	1

3) Review of Permeation Amount for Vehicles Under Japanese Regulations

Japanese plan (i): The current Japanese regulations are based on a high ventilation rate (0.18).

Japanese plan (ii): If we adopt the same ventilation rate as SAE and HySAFE, namely 0.03, hydrogen concentration will be 1.44%.

Japanese plan (iii): If we adopt the same size of container as HySAFE, namely 249 L, hydrogen concentration will be 1%, even with a ventilation rate of 0.03.

Japanese plan (iv): If we adopt the 55.6 garage size (same as SAE garage size), hydrogen concentration will be 1%, even with a ventilation rate of 0.03.

	Allowable Permeation Rate (Ncc/L/hr) [New at 15°C]	Allowable Permeation Rate (Ncc/L/hr) [New at 55°C]	Allowable Permeation Rate (Ncc/L/hr) [EOL at 55°C]	Storage Volume (L)	Allowable Permeation (Ncc/min)	Ventilation rate (ac/hr)	Garage Volume (m3)	Maximum Hydrogen Concentration (%)
Japan (i)	5	22	44	360	264	0.18	36.24	0.17
Japan (ii)	5	22	44	360	264	0.03	36.24	1.44
Japan (iii)	5	22	44	249	182.6	0.03	36.24	1
Japan (iv)	4.9	23.3	45.7	360	274	0.03	55.6	1

4) Summary of the Comparison

The permeation rate for containers calculated from the SAE's permeation amount for vehicles (150 cc/min) (the severest value among large cars, small cars, and mini cars) is about 5 Ncc/L/hr, which is the same value as that of Japanese regulations. Further, this value is severer than 6 Ncc/L/hr, the value under HySAFE plan.

5) Proposal to gtr

[Proposal of a gtr draft]

We propose that the gtr draft satisfy either of the two conditions below. We propose the condition (ii) as an alternative.

(i) Current gtr draft (Fig. 3)

150 cc/min@55°C

$$=150 \cdot (\text{Vehicle Length}+1) \cdot (\text{Vehicle Width}+1) \cdot (\text{Vehicle Height}+0.5) / 30.4$$

(ii) The definition is given with the permeation amount per liter of the container and the value is 46cc/L/hr@55°C in leakage/permeation test after gas cycle test (Fig. 5).

[(ii) Reasons for the proposal]

* If we define permeation amount in relation to garage volume and vehicle size, we have to manage the combinations of container size and vehicle size. We want to spare this management work.

*The value of 46 cc/L/hr@55°C takes into account a higher degree of deterioration compared to 5 cc/L/hr@15°C for new containers. Therefore it takes into account the actual performance of currently used containers and is applicable to these containers.

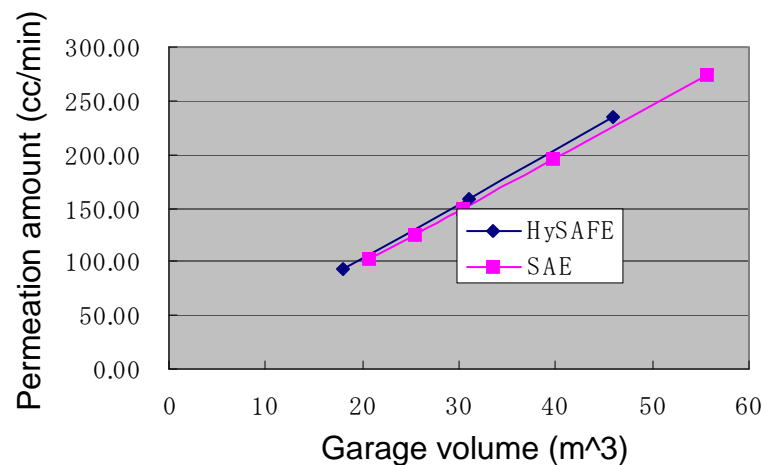


Fig. 3

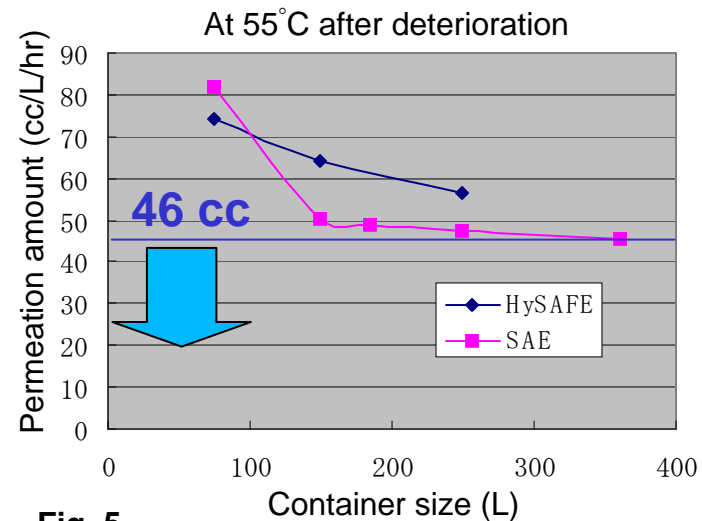


Fig. 5

6) Detailed Data

Fig. 1: Shows the difference of garage volumes for vehicles between HySAFE and SAE.

Fig. 2: In this review, we assumed that container size is the same for all vehicle sizes.

Fig. 3: Permeation amounts in relation to garage volumes (cc/min) are the same between SAE and HySAFE.

This is because HySAFE defines the permeation amounts of new containers according to vehicle sizes.

Fig. 4: Shows permeation amounts in relation to container sizes. The size of container changes with the size of vehicles and garage volumes (Fig. 1, Fig. 2).

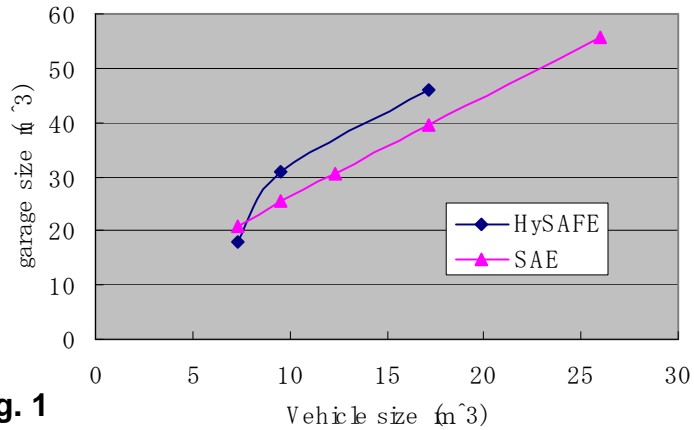


Fig. 1

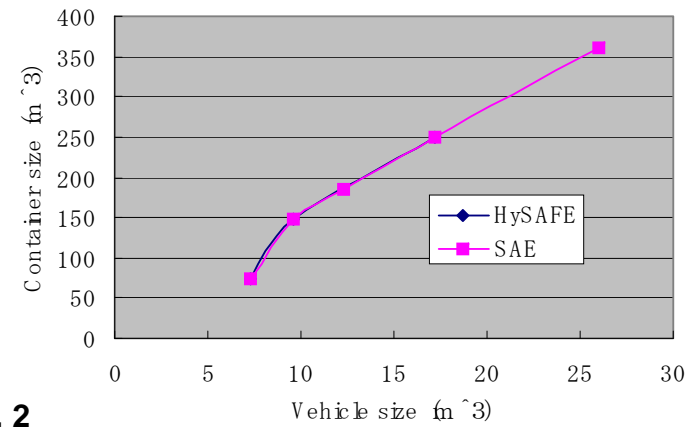


Fig. 2

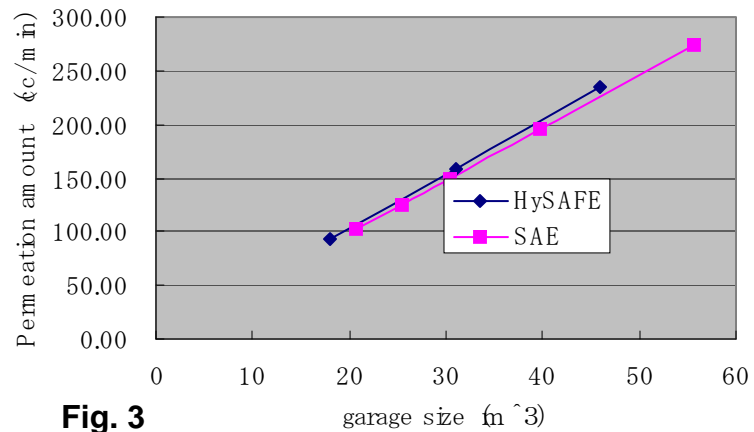


Fig. 3

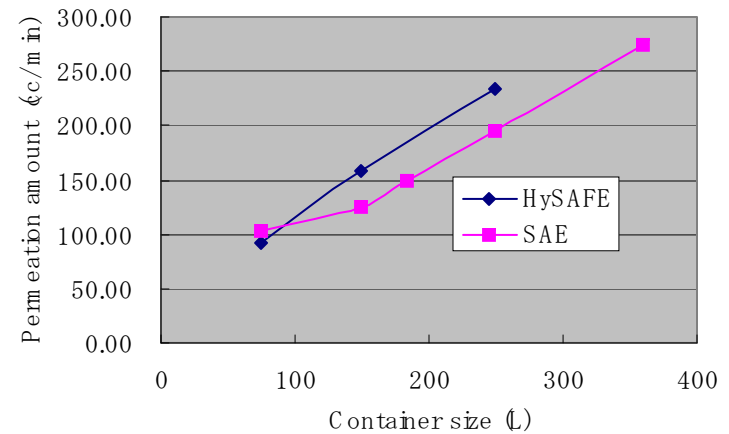


Fig. 4

Fig. 5: Shows the permeation amount of containers after deterioration (after gas cycle test) per liter and per hour in relation to container sizes.

Fig. 6: Shows the permeation amount of new containers at 55°C per liter and per hour in relation to container sizes.

Fig. 7: Shows the permeation amount of new containers at 15°C per liter and per hour in relation to container sizes.

Fig. 8: Shows the permeation amount of containers after deterioration (after gas cycle test) per liter and per hour in relation to garage volumes.

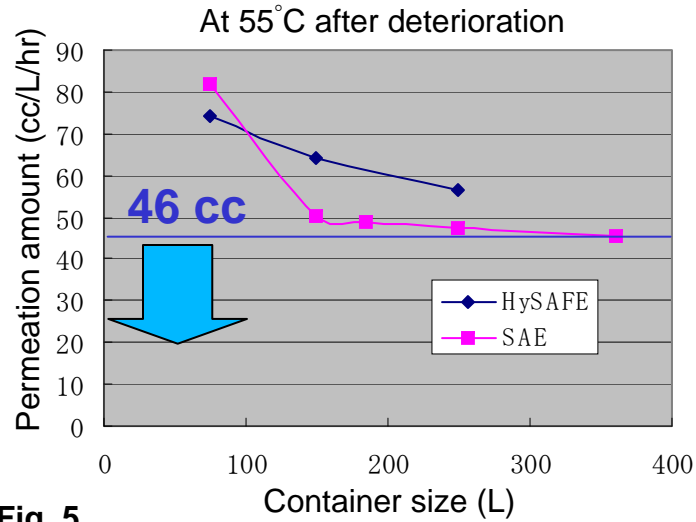


Fig. 5

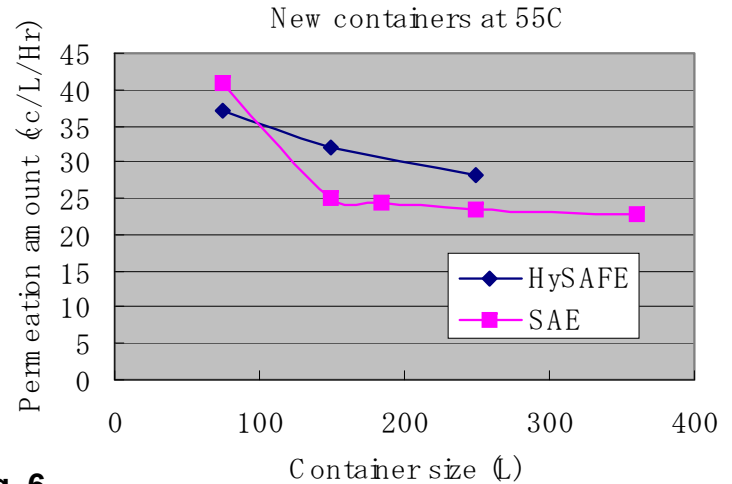


Fig. 6

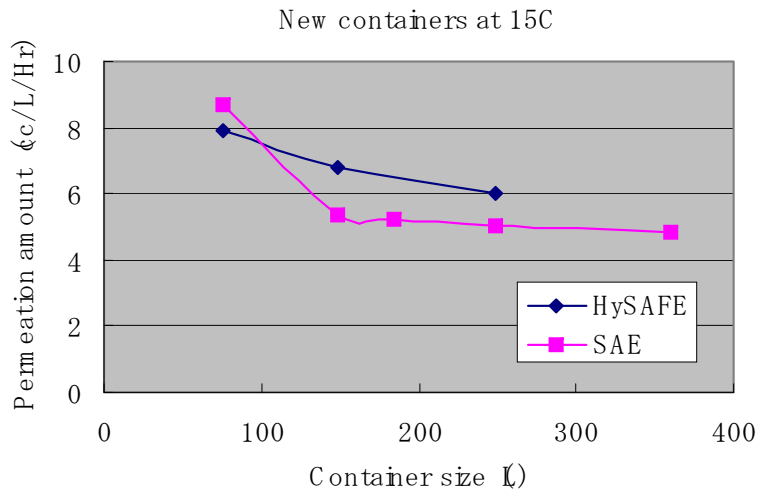


Fig. 7

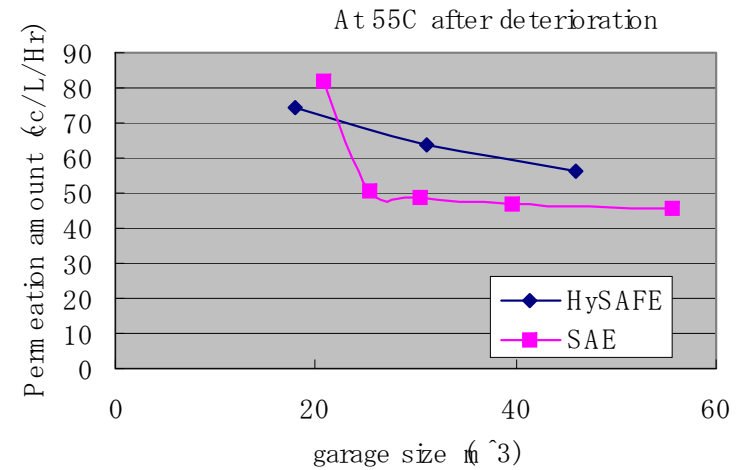


Fig. 8