Synthesis of barium peroxide – Protocol C

$$Ba + O_2 \rightarrow BaO_2$$

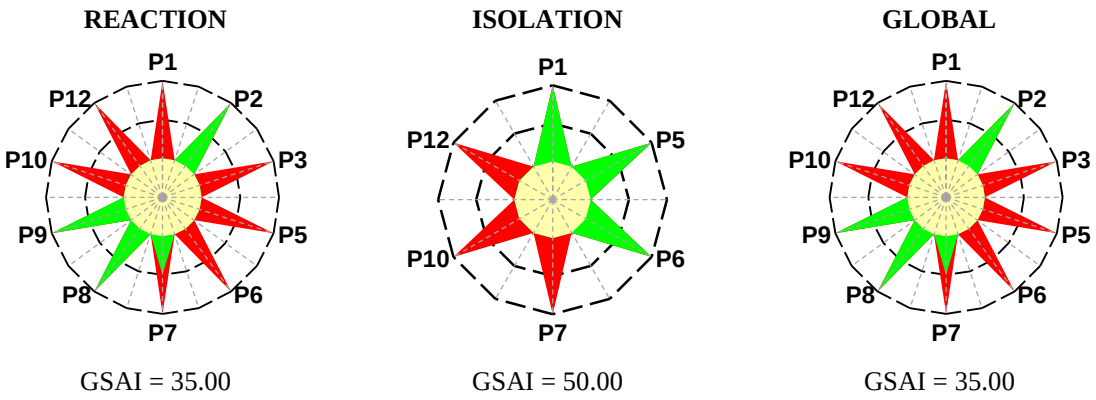
Reaction. Wash the barium free from paraffin oil with light petroleum and dry on a filter paper. Weigh 1.5 – 2.0 g of the metal and divide this into three or more pieces. Place the pieces in nickel boats in the furnace tube. Connect the oxygen cylinder directly to the furnace tube. A Drechsel bottle containing concentrated sulphuric acid is included on the exit side of the furnace as a ready method of checking the gas flow rate. Heat the furnace tube to 500-550 ºC in an oxygen flow of 4-6 cm^3/s for about one hour.

Isolation. Cool the tube while maintaining the oxygen flow. Remove the product and break into smaller pieces with a pestle and mortar.

Purification. Not prescribed.

Safety. See hazards associated with the reagents in Table 1.

Greenness Assessment. The evaluation was performed using the Green Star (GS) and the results are shown in Figure 1.



GSAI = 35.00 GSAI = 50.00 GSAI = 35.00

Figure 1. Greenness assessment (GS) for the synthesis of barium peroxide

Construction of the GS

$$Ba + O_2 \rightarrow BaO_2$$

Table 1 presents the hazards and scores associated with the substances involved and Table 2 presents the scores used to construct the green stars.

Table 1. Hazards for the synthesis of barium peroxide, protocol C[α]

Substances involved	Step			Hazard code	Score: hazards to...		
	R	I	Pu		HH	E	P
Stoichiometric reagents							
Barium (CAS 7440-39-3)	✓			H315, H319, H335	2	1	1
Oxygen[a] (CAS 7782-44-7)	✓			H270, H280	1	1	3
Auxiliary substances							
Solvents							
Petroleum ether (CAS 8032-32-4)	✓			H224, H304, H315, H336, H411	3	3	3
Other auxiliary substances							
Oxygen[a] (CAS 7782-44-7)	✓	✓		H270, H280	1	1	3
Sulphuric acid (CAS 7664-93-9)	✓			H314	3	1	1
Product							
Barium peroxide (1304-29-6)	✓	✓		H272 (cat. 2), H302, H332	2	1	3
Waste							
Petroleum ether	✓			H224, H304, H315, H336, H411	3	3	3
Sulphuric acid (solution)	✓			H314	3	1	1

[α] R – Reaction; I – Isolation; Pu – Purification; HH – Human Health; E – Environment; P – Physical

[a] Renewable

Table 2. Scores used to construct the green star for the synthesis of barium peroxide, protocol C[α]

Green Chemistry Principle	Reaction		Isolation		Global	
	s	**Explanation**	**s**	**Explanation**	**s**	**Explanation**
P1 Prevention	1	Petroleum ether, H304 and H411, sulphuric acid, H314	3	Without waste	1	Petroleum ether, H304 and H411, sulphuric acid, H314
P2 Atom Economy	3	Stoichiometric proportions of reagents, without formation of by-products		NA	3	Stoichiometric proportions of reagents, without formation of by-products
P3 Less hazardous chemical synthesis	1	Petroleum ether, H304 and H411, sulphuric acid, H314		NA	1	Petroleum ether, H304 and H411, sulphuric acid, H314
P5 Safer solvents and auxiliary substances	1	Petroleum ether, H304 and H411, sulphuric acid, H314	3	Oxygen	1	Petroleum ether, H304 and H411, sulphuric acid, H314
P6 Increase energy efficiency	1	T > 100 ºC	3	Room temperature	1	T > 100 ºC
P7 Use renewable feedstocks	2	Oxygen is renewable	1	Substances not renewable	2	Oxygen is renewable
P8 Reduce derivatives	3	One stage		NA	3	One stage
P9 Catalysts	3	Without catalysts		NA	3	Without catalysts
P10 Design for degradation	1	Substances not degradable	1	Substances not degradable	1	Substances not degradable
P12 Safer chemistry for accident prevention	1	Oxygen, H270, petroleum ether, H224, sulphuric acid, H314, and barium peroxide, H272 (cat.2)	1	Oxygen, H270, and barium peroxide, H272 (cat.2)	1	Oxygen, H270, petroleum ether, H224, sulphuric acid, H314, and barium peroxide, H272 (cat.2)

[α]s – Score; NA – Not applicable

References

Pass, G.; Sutcliffe, H. *Practical Inorganic Chemistry – 2nd edition*. Chapman and Hall: London, 1974, pp. 34-35.