'DOUBLE DISPLACEMENT REACTION' IS A MISNOMER IN CHEMISTRY

Renu Parashar
Associate Professor,
Department of Chemistry,
Hansraj College, University of Delhi

R. K. Parashar
Professor, Department of Education in Science and Mathematics,
NCERT, New Delhi

The introductory science curriculum deals with physical and chemical changes. Under the chemical changes, various chemical changes/ reaction types, including single displacement and double displacement, are discussed separately. However, on keen observation and analysis, one can conclude that both types can be termed as simply displacement/replacement reactions.

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Introduction

School science curriculum worldwide generally includes chemical reactions in which combination, decomposition, displacement (single and double), combustion, etc., are explained. (Soult A , 2020; Encyclopedia.com, 2022)

Single displacement reaction is usually generalized as

$A^+B^- + C \rightarrow C^+B^- + A$

$CuSO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + Cu(s)$

In this reaction , reactants contain Cu^{2+}, SO_4^{2-} ions and Zn(s) and products Zn^{2+} and SO_4^{2-} and Cu(s). Here only one new product i.e Cu(s) is formed and SO_4^{2-} ion is common in both reactants and products , hence justify the term 'Single-displacement' reaction.

Now let us consider double displacement reaction which is generalized as

$A^+B^- + C^+D^- \rightarrow A^+D^- + C^+B^-$

If we take the following example

$NaNO_3(aq) + KCl(aq) \rightarrow NaCl(aq) + KNO_3(aq)$.....(i)

Here reactants and products both contain Na^+ , NO_3^-, K^+ and Cl^- ions. Hence this is not an example of chemical reaction at all but it's a mixture of ions. In some references (Shriver, 1998; Flexbooks 2.0, 2022)double-displacement/replacement is further classified into the following three types:

1) Precipitation reaction

$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$.....(ii)

In this reaction, a new product, i.e., $BaSO_4(s)$, is formed by replacing the Cl^- ion of $BaCl_2$ with SO_4^{2-} ion from Na_2SO_4. Here Na^+ions and Cl^- ions are present both in the reactants and products. So it should be taken as the example of single displacement/replacement only.

2) Neutralization reaction

$CH_3COOH(aq) + NH_4OH(aq) \rightarrow CH_3COONH_4(aq) + H_2O(l)$.....(iii)

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(aq)$.....(iv)

In reaction (iii), reactants contain undissociatedCH_3COOH / NH_4OH along with CH_3COO^-, OH^-, H^+, and NH_4^+ ions. Products contain CH_3COO^-, $NH4^+$ ions, and undissociated H_2O. So only one new product, i.e., H_2O, is formed. So again, it should be taken as the example of single displacement /replacement only. Similarly, for reaction (iv), only one new product, H_2O, is formed by a single displacement/ replacement process, and Na^+, Cl^- ions are common in both reactants and products.

3) Gas formation reaction

Na2S(aq) + 2HCl(aq)→ H2S(g)+2NaCl(aq) (v)

In this reaction too Na+ and Cl- are common to both reactants and products. A new product H2S(g) is formed by the displacement Cl- by S2- ions.

Conclusion

Looking back to examples (i)-(v), it is clear that all the examples are given under the terminology' double-displacement/ replacement' are basically examples of single displacement/ replacement reaction. Therefore, it is recommended that the term double-displacement/replacement not be used as basic chemical terminology; instead, simply displacement/replacement reaction suffices the purpose.

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