

## Coordination Complex (Theory)

### THEORITICAL DETERMINATION OF SPINEL STRUCTURE

1. With the help of lattice energy
2. OSSE : Octahedral site stabilization energy

	Tetrahedral	Octahedral
CFSE $A^{+2}$	$ z $	$ x $
CFSE $B^{+3}$	$ w $	$ y $

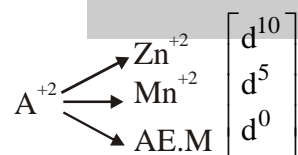
\* If  $(OSSE)_{B^{+3}} > (OSSE)_{A^{+2}}$  Normal spinel structure is favoured.

\* If  $(OSSE)_{B^{+3}} < (OSSE)_{A^{+2}}$  Inverse spinel structure is favoured.

#### Case 1:

$A^{+2}$   $|x| = 0$  i.e.  $(OSSE)_{A^{+2}}$  is zero

$B^{+3}$   $|y| \neq 0$



⇒ Normal spinel structure will be favoured. E.g.  $ZnCO_3 \cdot O_4$

#### Case 2:

$|x| \neq 0$        $|y| = 0$

$(A^{+2})$        $(B^{+3})$

Generally  $(B^{+3})$  is (a)  $Fe^{+3}$

(b)  $Al^{+3}$

Spinels of  $Fe^{+3}$  are inverse.

But spinels of  $Al^{+3}$  will be normal, because very high Lattice energy of  $Al^{+3}$  in octahedral void even more than CFSE of transition metal except for

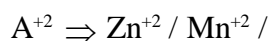
$NiAl_2O_4 \rightarrow$  "Inverse"

$Ni^{+2} \rightarrow d^8$

Very high CFSE & verh high  $Z_{eff}$  of  $Ni^{+2}$   $\therefore$  occupies octahedral void  $\Rightarrow$  Inverse spinel structure

**Case 3:**

$$|x| = 0$$



Alkaline metals

$$|y| = 0$$



Always normal, because high charge, high C.No. Except  $MnFe_2O_4$  ( $\lambda = 0.1$ )

**Questions:** Predict the type of structure of spinel?

- (a)  $Mn_3O_4$  (Normal)
- (b)  $Co_3O_4$  (Normal)
- (c)  $ZnCO_2O_4$  (Normal)
- (d)  $NiAl_2O_4$  (Inverse)
- (e)  $FeAl_2O_4$  (Normal)
- (f)  $CoAl_2O_4$  (Normal)
- (g)  $NiFe_2O_4$  (Inverse)

Answer (d) Normal

CHEM ACADEMY