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Hyper-Revan Indices and their Polynomials of Silicate Networks

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Abstract: We propose the first and second hyper-Revan indices of a molecular graph. Considering these hyper-Revan indices, we define the first and second hyper-Revan polynomials of a graph. In this paper, we compute the first and second hyper-Revan indices and their polynomials of certain family of networks such as silicate networks.

MSC: 05C05, 05C07, 05C35.

Keywords: Hyper-Revan indices, silicate network.

1. Introduction

A molecular graph is a graph whose vertices correspond to the atoms and the edges to the bonds, Chemical graph theory has an important effect on the development of Chemical Sciences, see [1]. Let G be a finite, simple, connected graph with vertex set *V(G)* and edge set *E(G)*. The degree $d_G(v)$ of a vertex v is the number of vertices adjacent to v. Let $\Delta(G)(\delta(G))$ denote the maximum (minimum) degree among the vertices of G. The revan vertex degree of a vertex v in G is defined as $r_G(v) = \Delta(G) + \delta(G) - d_G(v)$. The revan edge connecting the revan vertices u and v will be denoted by uv. We refer [2], for other undefined notations and terminologies. The first and second Revan indices of a graph G are defined as

$$R_1(G) = \sum_{uv\in E(G)} \left[r_G(u) + r_G(v)\right], \quad R_2(G) = \sum_{uv\in E(G)} r_G(u)\, r_G(v).$$

The Revan indices were introduced by Kulli in [3] and were studied, for example, in [4, 5]. Considering the Revan indices, the first and second Ravan polynomials [6] of a graph were defined as follows:

The first and second Revan polynomials of a graph G are defined as

$$R_1(G,x) = \sum_{uv\in E(G)} x^{r_G(u)+r_G(v)}, \quad R_2(G,x) = \sum_{uv\in E(G)} x^{r_G(u)r_G(v)}.$$

We introduce the first and second hyper-Revan indices as

$$HR_1(G) = \sum_{uv\in E(G)} \left[r_G(u) + r_G(v)\right]^2, \quad HR_2(G) = \sum_{uv\in E(G)} \left[r_G(u)\, r_G(v)\right]^2.$$

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Considering hyper-Revan indices, we propose the first and second hyper-Revan polynomials of a graph G as

$$HR_1(G,x)=\sum_{uv\in E(G)} x^{[r_G(u)+r_G(v)]^2},\quad HR_2(G,x)=\sum_{uv\in E(G)} x^{[r_G(u)r_G(v)]^2}.$$

The third Revan index [3] of a graph G is defined as

$$R_3(G)=\sum_{uv\in E(G)} |r_G(u)-r_G(v)|.$$

Considering the third Revan index, Kulli defined the third Revan polynomial [5] as

$$R_3(G,x)=\sum_{uv\in E(G)} x^{|r_G(u)-r_G(v)|}.$$

Recently, several topological indices were studied, for example, in [7–17]. In this paper, the first and second hyper-Revan indices and their polynomials of silicate networks are determined. For silicate networks see [5].

2. Results

A silicate network is symbolized by SL_n where n is the number of hexagons between the center and boundary of SL_n. These networks are obtained by fusing metal oxides or metal carbonates with sand. A silicate network of dimension 2 is depicted in Figure 1.

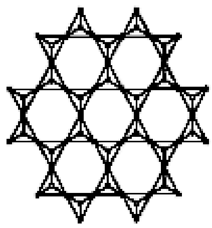

Figure 1: A 2-dimensional silicate network

Let G be the graph of silicate network SL_n. By calculation, G has $15n^2+3n$ vertices and $36n^2$ edges. From Figure 1, it is easy to see that the vertices of SL_n are either of degree 3 or 6. Thus $\Delta(G)=6$, $\delta(G)=3$ and therefore $r_G(u)=9-d_G(u)$. In SL_n, by algebraic method, there are three types of edges based on the degree of the vertices of each edge as follows:

$$E_{33}=\{uv\in E(G)|d_G(u)=d_G(v)=3\},\quad |E_{33}|=6n.$$

$$E_{36}=\{uv\in E(G)|d_G(u)=3,d_G(v)=6\},\quad |E_{36}|=18n^2+6n.$$

$$E_{66}=\{uv\in E(G)|d_G(u)=d_G(v)=6\},\quad |E_{66}|=18n^2-12n.$$

Thus there are three types of Revan edges based on the degree of end Revan vertices of each Revan edge as given in Table 1.

$r_G(u)$, $r_G(v)$ / $uv\in E(G)$	(6,6)	(6, 3)	(3,3)
Number of edges	6n	$18n^2$+ 6n	$18n^2-12n$

Table 1: Revan edge partition of G

In the following theorem, we compute the value of $R_1(SL_n,x)$, $R_2(SL_n,x)$ for silicate networks.

Theorem 2.1. *The first and second Revan polynomials of a silicate network are given by*

(1). $R_1(SL_n, x) = 6nx^{12} + (18n^2 + 6n)x^9 + (18n^2 - 12n)x^6.$

(2). $R_2(SL_n, x) = 6nx^{36} + (18n^2 + 6n)x^{18} + (18n^2 - 12n)x^9.$

Proof. Let G be the graph of silicate network SL_n.

(1). By using the partition given in Table 1, we can apply the formula of the first Ravan Polynomial of silicate network SL_n. Since $R_1(G, x) = \sum_{uv \in E(G)} x^{r_G(u)+r_G(v)}$, this implies that

$$\begin{aligned} R_1(SL_n, x) &= 6nx^{6+6} + (18n^2 + 6n)x^{6+3} + (18n^2 - 12n)x^{3+3}. \\ &= 6nx^{12} + (18n^2 + 6n)x^9 + (18n^2 - 12n)x^6. \end{aligned}$$

(2). By using the partition given Table 1, we can apply the formula of the second Revan Polynomial of silicate network SL_n. Since $R_2(G, x) = \sum_{uv \in E(G)} x^{r_G(u)r_G(v)}$, this implies that

$$\begin{aligned} R_1(SL_n, x) &= 6nx^{6\times 6} + (18n^2 + 6n)x^{6\times 3} + (18n^2 - 12n)x^{3\times 3}. \\ &= 6nx^{36} + (18n^2 + 6n)x^{18} + (18n^2 - 12n)x^9. \end{aligned}$$

□

In the following theorem, we compute the third Revan index and its polynomial of silicate networks.

Theorem 2.2. *The third Revan index and its polynomial of a silicate network are given by*

(1). $R_3(SL_n) = 54n^2 + 18n.$

(2). $R_3(SL_n, x) = (18n^2 + 6n)x^3 + (18n^2 - 6n).$

Proof. Let G be the graph of silicate network SL_n.

(1). By using the partition given in Table 1, we can apply the formula of the third Revan index of silicate network SL_n. Since $R_3(G) = \sum_{uv \in E(G)} |r_G(u) - r_G(v)|$, this implies that

$$\begin{aligned} R_3(SL_n) &= 6n \times 0 + \left(18n^2 + 6n\right)3 + \left(18n^2 - 12n\right) \times 0. \\ &= 54n^2 + 18n. \end{aligned}$$

(2). By using the partition given in Table 1, we can apply the formula of the third Revan Polynomial of silicate network SL_n. Since $R_3(G, x) = \sum_{uv \in E(G)} x^{|r_G(u) - r_G(v)|}$, this implies that

$$\begin{aligned} R_3(SL_n, x) &= 6nx^0 + \left(18n^2 + 6n\right)x^3 + \left(18n^2 - 12n\right)x^0. \\ &= \left(18n^2 + 6n\right)x^3 + \left(18n^2 - 6n\right). \end{aligned}$$

□

In the following theorem, we compute the value of $HR_1(SL_n)$ and $HR_2(SL_n)$ for silicate networks.

Theorem 2.3. *The first and second hyper-Revan indices of a silicate network are given by*

(1). $HR_1(SL_n) = 2106n^2 + 918n$.

(2). $HR_2(SL_n) = 7290n^2 + 8748n$.

Proof. Let G be the graph of silicate network SL_n.

(1). By using the partition given in Table 1, we can apply the formula of the first hyper-Revan index of G. Since $HR_1(G) = \sum_{uv\in E(G)} [r_G(u) + r_G(v)]^2$, this implies that

$$\begin{aligned} HR_1(SL_n) &= 6n(6+6)^2 + \left(18n^2+6n\right)(6+3)^2 + \left(18n^2-12n\right)(3+3)^2 . \\ &= 2106n^2 + 918n. \end{aligned}$$

(2). By using the partition given in Table 1, we can apply the formula of the second hyper-Revan index of G. Since $HR_2(G) = \sum_{uv\in E(G)} [r_G(u)\, r_G(v)]^2$, this implies that

$$\begin{aligned} HR_2(SL_n) &= 6n(6\times 6)^2 + \left(18n^2+6n\right)(6\times 3)^2 + \left(18n^2-12n\right)(3\times 3)^2 . \\ &= 7290n^2 + 8748n. \end{aligned}$$

□

In the following theorem, we compute the first and second hyper-Revan polynomials of silicate networks.

Theorem 2.4. *The first and second hyper-Revan Polynomials of a silicate network are given by*

(1). $HR_1(SL_n, x) = 6nx^{144} + (18n^2+6n)x^{81} + (18n^2-12n)x^{36}$.

(2). $HR_2(SL_n, x) = 6nx^{1296} + (18n^2+6n)x^{328} + (18n^2-12n)x^{81}$.

Proof. Let G be the graph of silicate network SL_n.

(1). By using the partition given Table 1, we can apply the formula of the first hyper-Revan polynomial of a silicate network SL_n. Since $HR_1(G,x) = \sum_{uv\in E(G)} x^{[r_G(u)+r_G(v)]^2}$, this implies that

$$\begin{aligned} HR_1(SL_n, x) &= 6nx^{(6+6)^2} + \left(18n^2+6n\right)x^{(6+3)^2} + \left(18n^2-12n\right)x^{(3+3)^2}. \\ &= 6nx^{144} + (18n^2+6n)x^{81} + (18n^2-12n)x^{36}. \end{aligned}$$

(2). By using the partition given in Table 1, we can apply the formula of the second hyper-Revan polynomial of a silicate network SL_n. Since $HR_2(G,x) = \sum_{uv\in E(G)} x^{[r_G(u)r_G(v)]^2}$, this implies that

$$\begin{aligned} HR_2(SL_n, x) &= 6nx^{(6\times6)^2} + \left(18n^2+6n\right)x^{(6\times3)^2} + \left(18n^2-12n\right)x^{(3\times3)^2}. \\ &= 6nx^{1296} + (18n^2+6n)x^{324} + (18n^2-12n)x^{81}. \end{aligned}$$

□

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