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Compilation of Instantaneous Source Functions for Varying Architecture of a Layered Reservoir with Mixed Boundaries and Horizontal Well Completion Part I: Normal and Inverted Letter 'e' Architecture

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Abstract

Instantaneous source functions have been compiled and tabulated for both normal and inverted two-layered reservoir of letter 'e' architecture. The source functions describe fluid flow in horizontal wells drilled in each layer. Possibility of the existence of all flow periods was considered for each well.

Results obtained show that letter 'e' architecture yields thirty-two (32) different models with different variations of its five external boundaries, which may be sealed or constant-pressured. The inverted architecture also yields thirty-two (32) different models of varying sealing and constant-pressure boundaries. Vertical inversions turns top of the architecture bottom and bottom top, while horizontal inversion merely turns the top of a horizontal well bottom and bottom top. In other words, all the forms (normal and inverted) of letter 'e' architecture will collectively yield one hundred and twenty-eight (128) different models with different variations of sealing and constant-pressure boundaries. Finally, any form of the letter 'e' architecture has one mandatory 'infinitely far away' external boundary.

1.0 Introduction

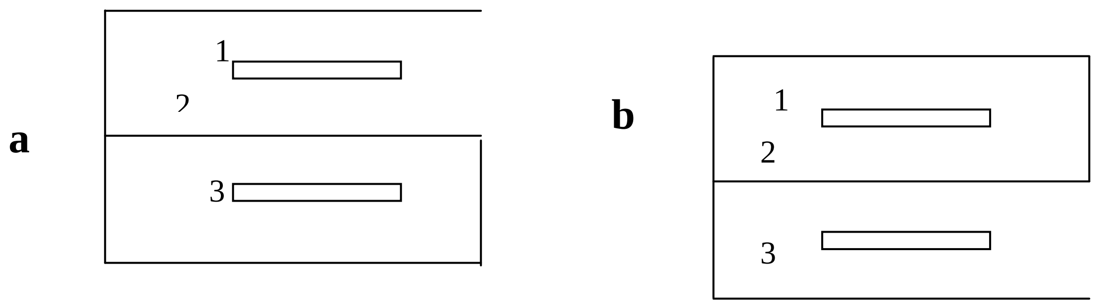
Two-layered reservoirs with normal and inverted letter 'e' architecture are another reservoir architecture encountered in practice. Each of the layers may be completed with a vertical well or horizontal well separately. On the other hand, for a permeable interface (crossflow), the two layers may be drained together with one well, whether a horizontal or vertical well. This is a more economical production option than individual layer production, if the layers fluids have close properties. Under primary fluid recovery from the layers, natural external influences, such as water influx or gas cap expansion, may necessitate special completion requirements to achieve optimum recovery. In the same manner, when the layers are subjected to fluid recovery by secondary or tertiary methods, it is still necessary to monitor injected fluid to avoid unwanted injected fluid breakthrough.

Thus, it is useful to understand the behavior of such reservoir systems for the purpose of correct characterization and optimization. Hence, in this paper source functions are derived for these kinds of reservoir systems for the purpose of deriving and studying their pressure and pressure derivative distributions, which are important tools for reservoir characterization. Some other architectures are studied in Part II, III and IV in a series.

Normal and Inverted Letter 'e' Two-Layered Reservoir Description

Figs. 1 a and **b** below show, respectively, the normal and inverted letter 'e' two-layered reservoirs with horizontal well completions. The normal letter 'e' architecture has the upper layer fully bounded and the lower layer having two boundaries at right angles and one ‘infinitely far away’ boundary. That is, the normal architecture has five (5) boundaries that may be sealed or constant-pressured. Therefore, in terms of well location in each layer, the lower layer presents lesser restriction than the upper layer, because Layer 1 has a larger sweep area than Layer 2 given the same rate histories, well type, layers and layers’ fluid properties.

The inverted architecture on the other hand is the mirror image of the normal architecture along a vertical axis. That is, the upper layer of the inverted model has two boundaries at right angles and an ‘infinitely far away’ boundary while the lower layer has three boundaries, thus affording five external boundaries that can either be sealed or constant-pressured. In both architectures, inter-layer crossflow fluid production or injection using one well may be marred severely by the unequal transient spread from one layer to another because of the difference in sweep areas of the two layers.



Nomenclature
1 Horizontal well in Layer
2 Interface
3Horizontal well in Laver

Fig. 1: Normal and Inverted Letter ‘e’ Two-Layered Reservoir Architectures

Derivation of Instantaneous Source Functions

A horizontal well is a three dimensional source. Hence, all the instantaneous source functions are a product of three continuous sources from the x, y and z directions. This is the Newton product method[1], used for deriving solutions to 1D, 2D and 3D diffusivity equations governing fluid flow in reservoirs. The directional continuous functions, either for early or late flow time, ae as listed in Refs. 1 to 4, and reproduced in Appendix of Ref. 5. In these references, roman figure I and II are used for Green’s functions (i.e., early time source functions) and i to x , for late time source functions. The roman figure I in brackets after each roman figure denotes the direction of flow in x, y or z direction. Attempts were made as much as possible to contemplate all the possible flow periods that the horizontal wells might encounter.

The presence of an infinitely far away boundary in the lower layer of the normal model and in the upper layer of the inverted model offers useful advantage of large reservoir energy if wells in these layers are reasonably far away from the adjacent boundary. If this is achieved, then the most prevalent instantaneous source function is II(x). I(y). I(z), meaning that if the well length along the x-axis is located at the centre, then well flow will never ‘see’ the adjacent boundary. Furthermore, the instantaneous source functions iii(x). I(y).I(z), iii(x).I(y).iv(z) are suggested to cater for situations where the wells are off-centered and the vertical boundaries (along the z-axes) are felt. In all the models identified, the y axes are considered infinite.

Results and Discussion

Table 1 is a compilation of sixty-four (64) models and their instantaneous source functions possible for normal and inverted architectures. Models 1 to 32 are the normal architecture while Models 33 to 64 are for the inverted architecture. The inverted models yield source functions that are in the exact opposite directions of the normal models as a result of the mirror image of Model 1. Hence, the top of Model 1 is the bottom of Model 33, etc. but, if the mirror plane is turned horizontally, the tops of all horizontal wells become the bottoms of the image model as illustrated in Fig. 2 below. Therefore, for the four models as shown in Fig 2, there will be one hundred and twenty-eight (128) different models that can be generated with sealed and constant-pressured boundaries.

Note that in all the models, no constant-pressure boundary is imposed on 'infinitely far away' boundaries. This is deliberately done since it is considered that such boundaries already possess sufficiently high energy for fluid mobility. However, where well location would lead to eventual reduction of transient spread along a particular axis, the so called infinitely far away boundary would act as if it were also a sealed boundary. This behavior causes premature onset of pseudosteady state behavior (heralding final drainage), if no external constant-pressure boundary is felt earlier. The source functions like vii(x) and iii(x) are suggested where this behavior is mostly likely to prevail.

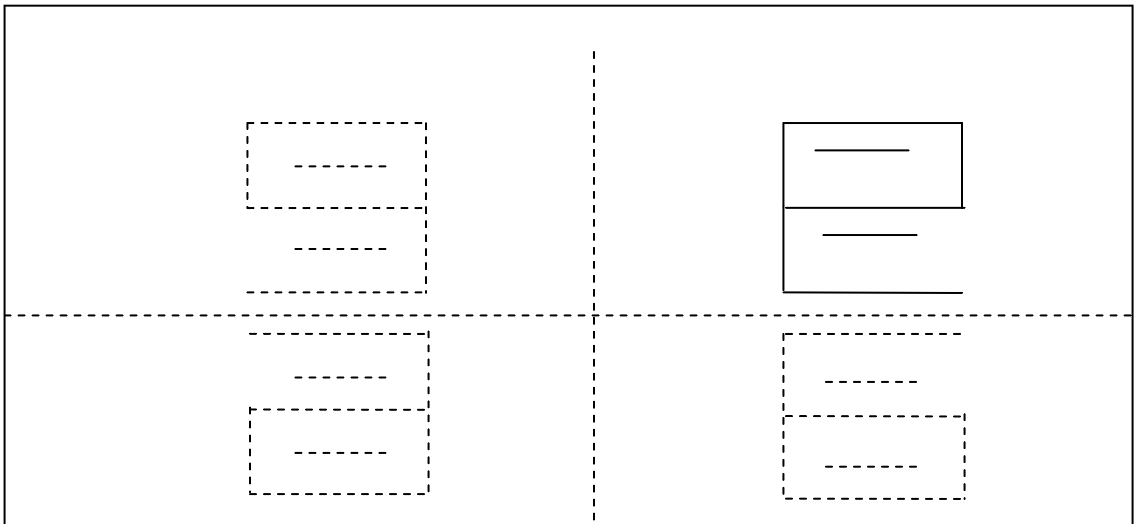
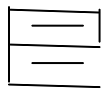
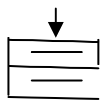
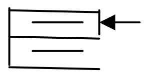
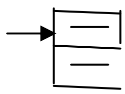
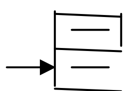
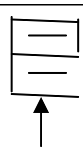
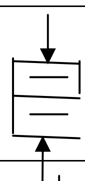
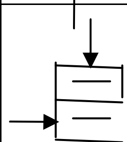
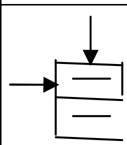
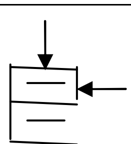
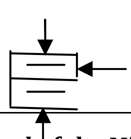


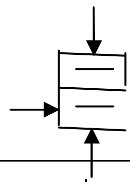
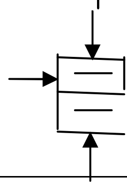
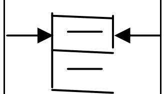
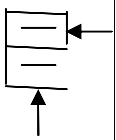
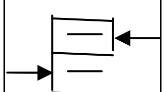
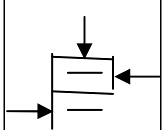
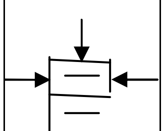
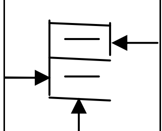
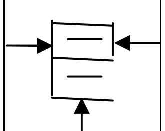
Fig. 2: Mirror Inversions of Letter 'e' Architecture (Not to scale)

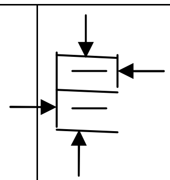
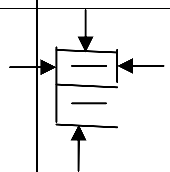
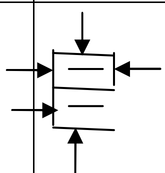
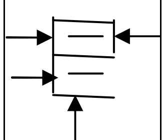
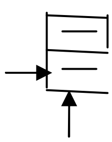
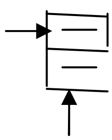
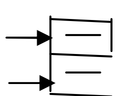
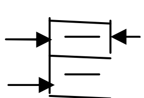
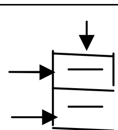
Examples are found in Layer 1 of Models 1, 2, 3, 4, 9, 10, 14 and 18, and Layer 2 of Models 33, 36, 37, 38, 46, 47, 48 and 58. In general, models with more constant-pressure external boundaries have fewer instantaneous source functions and the interface is considered as a constant-pressure boundary in all the models.

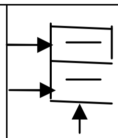
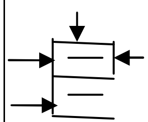
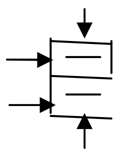
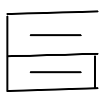
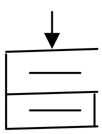
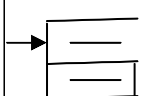
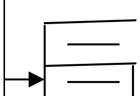
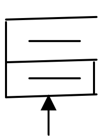
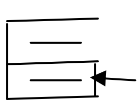
Finally, all the horizontal wells are treated as line sources. Hence, all the y-axes source functions are infinite sources in infinite reservoir, represented by the basic Green's function number I(i). A mandatory early time flow instantaneous source function of the kind II(x). I(y). I(z) is suggested for all the models for central well location along the well length axes. For off-centred location, the function I(x) may replace II(x). An appropriate well dimensioning would reveal the correct source function.

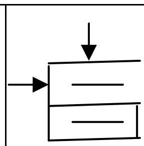
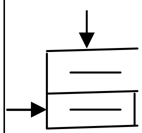
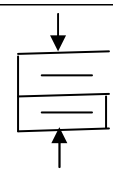
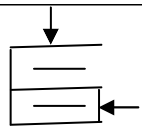
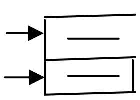
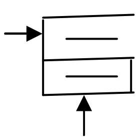
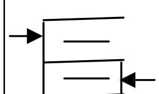
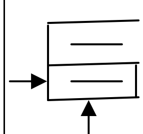
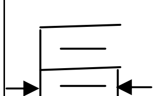
S/N	Model Diagram	Instantaneous Source Function			
		x-axis	z-axis	Layer 1	Layer 2

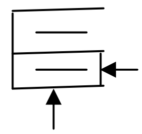
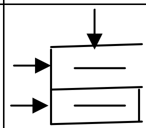
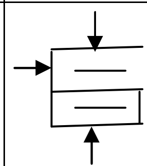
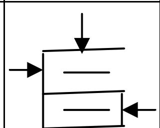
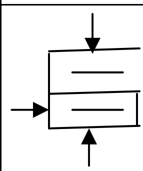
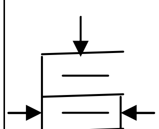
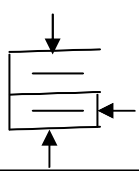
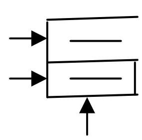
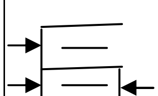
1.		Top layer, sealed ends. Bottom layer, sealed top, infinite bottom	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E_1II(x).I(y).v(z) E_1iii(x).I(y).I(z) E_1iii(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2vii(x).I(y).vi(z) E_2II(x).I(y).I(z) E_2iii(x).I(y).vi(z)
2.		Top layer, sealed ends. Bottom layer, sealed top, infinite bottom	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E_1II(x).I(y).v(z) E_1iii(x).I(y).I(z) E_1iii(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2vii(x).I(y).iv(z) E_2II(x).I(y).I(z)
3.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E_1II(x).I(y).v(z) E_1iii(x).I(y).I(z) E_1iii(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2v(x).I(y).vi(z) E_2II(x).I(y).I(z)
4.		Top layer, constant-pressure at bottom, sealed top. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E_1II(x).I(y).v(z) E_1iii(x).I(y).I(z) E_1iii(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2vi(x).I(y).vi(z) E_2II(x).I(y).I(z)
5.		Top layer, sealed ends. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E_1x(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2vii(x).I(y).vi(z) E_2II(x).I(y).I(z) E_2iii(x).I(y).vi(z)
6.		Top layer, sealed ends. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E_1II(x).I(y).iv(z) E_1vii(x).I(y).I(z) E_1iii(x).I(y).iv(z)	E_2vii(x).I(y).vi(z) E_2II(x).I(y).I(z) E_2iii(x).I(y).vi(z)
7.		Top layer, sealed ends. Bottom layer, sealed bottom, infinite top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E_1II(x).I(y).iv(z) E_1vii(x).I(y).I(z) E_1iii(x).I(y).iv(z)	E_2vii(x).I(y).iv(z) E_2II(x).I(y).I(z)
8.		Top layer, sealed ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E_1x(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2vii(x).I(y).iv(z) E_2II(x).I(y).I(z)
9.		Top layer, constant-pressure at bottom, sealed top. Bottom layer, sealed bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E_1II(x).I(y).v(z) E_1iii(x).I(y).I(z) E_1iii(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2vi(x).I(y).iv(z) E_2II(x).I(y).I(z)
10.		Top layer, constant-pressure at top, sealed bottom. Bottom layer, sealed bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E_1II(x).I(y).v(z) E_1iii(x).I(y).I(z) E_1iii(x).I(y).v(z) E_1II(x).I(y).I(z)	E_2v(x).I(y).iv(z) E_2II(x).I(y).I(z)
11.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, sealed	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface at top, constant-	E_1II(x).I(y).iv(z) E_1vii(x).I(y).I(z) E_1iii(x).I(y).iv(z)	E_2v(x).I(y).iv(z) E_2II(x).I(y).I(z)

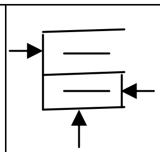
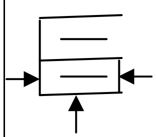
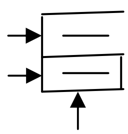
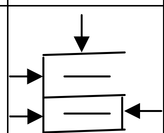
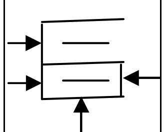
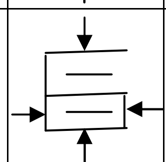
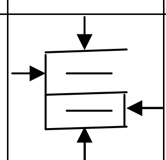
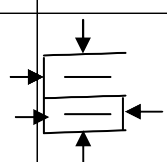
		bottom, infinite top	pressure at bottom		
12.		Top layer, sealed ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface at top, constant-pressure at bottom	E_1x(x).I(y).iv(z) E_1vii(x).I(y).I(z)	E_2vii(x).I(y).iv(z) E_2II(x).I(y).I(z)
13.		Top layer, constant-pressure at bottom, sealed top. Bottom layer, sealed bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface at top, constant-pressure at bottom	E_1II(x).I(y).iv(z) E_1vii(x).I(y).I(z) E_1iii(x).I(y).iv(z)	E_2vi(x).I(y).iv(z) E_2II(x).I(y).I(z)
14.		Top layer, constant-pressure at ends. Bottom layer, sealed top, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1II(x).I(y).v(z) E1iii(x).I(y).I(z) E1iii(x).I(y).v(z) E1II(x).I(y).I(z)	E2viii(x).I(y).vi(z) E2II(x).I(y).I(z)
15.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1II(x).I(y).iv(z) E1vii(x).I(y).I(z) E1iii(x).I(y).iv(z)	E2v(x).I(y).vi(z) E2II(x).I(y).I(z)
16.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, constant-pressure at bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).I(z)	E2v(x).I(y).vi(z) E2II(x).I(y).I(z)
17.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).I(z)	E2v(x).I(y).iv(z) E2II(x).I(y).I(z)
18.		Top layer, constant-pressure at both ends, bottom layer, sealed bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E1II(x).I(y).v(z) E1iii(x).I(y).I(z) E1iii(x).I(y).v(z) E1II(x).I(y).I(z)	E2viii(x).I(y).iv(z) E2II(x).I(y).I(z)
19.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, constant-pressure, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2v(x).I(y).vi(z) E2II(x).I(y).I(z)
20.		Top layer, constant-pressure at both ends, bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1II(x).I(y).iv(z) E1vii(x).I(y).I(z) E1iii(x).I(y).iv(z)	E2viii(x).I(y).vi(z) E2II(x).I(y).I(z)

21.		Top layer, sealed bottom, constant-pressure at top. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface at top, constant-pressure at bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2v(x).I(y).iv(z) E2II(x).I(y).I(z)
22.		Top layer, constant-pressure at both ends, bottom layer, sealed bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface at top, constant-pressure at bottom	E1II(x).I(y).iv(z) E1vii(x).I(y).I(z) E1iii(x).I(y).iv(z)	E2viii(x).I(y).iv(z) E2II(x).I(y).I(z)
23.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface at top, constant-pressure at bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2viii(x).I(y).iv(z) E2II(x).I(y).I(z)
24.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2viii(x).I(y).vi(z) E2II(x).I(y).I(z)
25.		Top layer, sealed ends. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z)
26.		Top layer, constant-pressure at bottom, sealed top. Bottom layer, sealed bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1II(x).I(y).iv(z) E1vii(x).I(y).I(z) E1iii(x).I(y).iv(z)	E2vi(x).I(y).vi(z) E2II(x).I(y).I(z)
27.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).I(z)	E2vi(x).I(y).vi(z) E2II(x).I(y).I(z)
28.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).I(z)	E1x(x).I(y).v(z) E1II(x).I(y).I(z)
29.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).I(z)	E2vi(x).I(y).iv(z) E2II(x).I(y).I(z)

30.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2vi(x).I(y).vi(z) E2II(x).I(y).I(z)
31.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).I(z)	E2viii(x).I(y).iv(z) E2II(x).I(y).I(z)
32.		Top layer, constant-pressure ends. Bottom layer, constant-pressure at bottom, infinite top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1x(x).I(y).iv(z) E1vii(x).I(y).I(z)	E2vi(x).I(y).iv(z) E2II(x).I(y).I(z)
33.		Top layer, sealed bottom, infinite top. Bottom layer, sealed ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1vii(x).I(y).v(z) E1iii(x).I(y).iii(z) E1iii(x).I(y).v(z) E1II(x).I(y).I(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)
34.		Top layer, sealed bottom, infinite top. Bottom layer, sealed ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1vii(x).I(y).v(z) E1iii(x).I(y).iii(z) E1iii(x).I(y).v(z) E1II(x).I(y).I(z)	E2vii(x).I(y).iv(z) E2II(x).I(y).I(z)
35.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1vii(x).I(y).v(z) E1iii(x).I(y).iii(z) E1iii(x).I(y).v(z) E1II(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
36.		Top layer, sealed bottom, infinite bottom. Bottom layer, constant-pressure at bottom, sealed top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).v(z) E1II(x).I(y).I(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)
37.		Top layer, sealed bottom, infinite top. Bottom layer, sealed ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1vii(x).I(y).iv(z) E1iii(x).I(y).iv(z) E1iii(x).I(y).I(z) E1II(x).I(y).I(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)
38.		Top layer, sealed bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1ix(x).I(y).v(z) E1II(x).I(y).I(z) E1II(x).I(y).v(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)

39.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1vii(x).I(y).v(z) E1iii(x).I(y).iii(z) E1iii(x).I(y).v(z) E1II(x).I(y).I(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)
40.		Top layer, sealed bottom, infinite bottom. Bottom layer, constant-pressure at bottom, sealed top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).v(z) E1II(x).I(y).I(z)	E2vii(x).I(y).iv(z) E2II(x).I(y).I(z)
41.		Top layer, sealed bottom, infinite top. Bottom layer, sealed ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1vii(x).I(y).iv(z) E1iii(x).I(y).iv(z) E1iii(x).I(y).I(z) E1II(x).I(y).I(z)	E2vii(x).I(y).iv(z) E2II(x).I(y).I(z)
42.		Top layer, sealed bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1ix(x).I(y).v(z) E1II(x).I(y).I(z) E1II(x).I(y).v(z)	E2vii(x).I(y).iv(z) E2II(x).I(y).I(z)
43.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at bottom, sealed top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).v(z) E1II(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
44.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1vii(x).I(y).iv(z) E1iii(x).I(y).iv(z) E1iii(x).I(y).I(z) E1II(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
45.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1ix(x).I(y).v(z) E1II(x).I(y).I(z) E1II(x).I(y).v(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
46.		Top layer, sealed bottom, infinite bottom. Bottom layer, constant-pressure at bottom, sealed top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1II(x).I(y).I(z) E1II(x).I(y).iv(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)
47.		Top layer, sealed bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1viii(x).I(y).v(z) E1viii(x).I(y).I(z) E1II(x).I(y).v(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)

48.		Top layer, sealed bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1 ix(x).I(y).iv(z) E1II(x).I(y).iv(z) E1ix(x).I(y).I(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)
49.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at bottom, sealed top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1x(x).I(y).v(z) E1II(x).I(y).v(z) E1II(x).I(y).I(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)
50.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1vii(x).I(y).iv(z) E1iii(x).I(y).iv(z) E1iii(x).I(y).I(z) E1II(x).I(y).I(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)
51.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1ix(x).I(y).v(z) E1II(x).I(y).I(z) E1II(x).I(y).v(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)
52.		Top layer, sealed bottom, infinite bottom. Bottom layer, constant-pressure at bottom, sealed top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1x(x).I(y).iv(z) E1II(x).I(y).I(z) E1II(x).I(y).iv(z)	E2vii(x).I(y).iv(z) E2II(x).I(y).I(z)
53.		Top layer, sealed bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1viii(x).I(y).v(z) E1viii(x).I(y).I(z) E1II(x).I(y).v(z)	E2vii(x).I(y).iv(z) E2II(x).I(y).I(z)
54.		Top layer, sealed bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1 ix(x).I(y).iv(z) E1II(x).I(y).iv(z) E1ix(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
55.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at bottom, sealed top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1II(x).I(y).I(z) E1II(x).I(y).iv(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
56.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, sealed bottom	E1viii(x).I(y).v(z) E1viii(x).I(y).I(z) E1II(x).I(y).v(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)

57.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1 ix(x).I(y).iv(z) E1II(x).I(y).iv(z) E1ix(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
58.		Top layer, sealed bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1 viii(x).I(y).iv(z) E1II(x).I(y).iv(z) E1viii(x).I(y).I(z)	E2vii(x).I(y).vi(z) E2II(x).I(y).I(z) E2iii(x).I(y).vi(z) E2iii(x).I(y).I(z)
59.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at bottom, sealed top	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1x(x).I(y).iv(z) E1II(x).I(y).I(z) E1II(x).I(y).iv(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
60.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, sealed bottom	E1viii(x).I(y).v(z) E1viii(x).I(y).I(z) E1II(x).I(y).v(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)
61.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, sealed top, interface bottom. Bottom layer, interface top, constant-pressure bottom	E1 viii(x).I(y).iv(z) E1II(x).I(y).iv(z) E1viii(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
62.		Top layer, sealed bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1 viii(x).I(y).iv(z) E1II(x).I(y).iv(z) E1viii(x).I(y).I(z)	E2x(x).I(y).vi(z) E2II(x).I(y).vi(z) E2II(x).I(y).I(z)
63.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, sealed bottom, constant-pressure at top	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1 ix(x).I(y).iv(z) E1II(x).I(y).iv(z) E1ix(x).I(y).I(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)
64.		Top layer, constant-pressure at bottom, infinite top. Bottom layer, constant-pressure at both ends	Top layer, constant-pressure at top, interface at bottom. Bottom layer, interface at top, constant-pressure at bottom	E1 viii(x).I(y).iv(z) E1II(x).I(y).iv(z) E1viii(x).I(y).I(z)	E2x(x).I(y).iv(z) E2II(x).I(y).I(z)

Conclusion

Instantaneous source functions are utilized a great deal in the derivation of reservoir system pressure and pressure derivative distributions. In this paper, all the instantaneous source functions of the normal and inverted architectures of a letter 'e' two-layered reservoir, completed with a horizontal wells, have been compiled. The external boundaries were varied as sealed and constant-pressured. Imagining a mirror reproduction of the normal architecture, three inverted architectures were observed. However, only the inverted architecture obtained through a vertical plane and the normal architectures were considered. It can be concluded that:

(1) One architecture produces thirty-two (32) different models; that is, two architectures produce sixty-four (64) different models, etc.
(2) Vertical inversion turns top of architecture bottom and bottom top.
(3) Horizontal inversion turns top of horizontal well bottom and bottom top.
(4) One form of the architecture has five (5) external boundaries that can be sealed or constant-pressured.

(5) The letter 'e' architecture, normal or inverted, is characterized by one 'infinitely far away external boundary
(6) For centrally located wells, the most prevalent instantaneous source function is II(x). I(y). I(z).

Nomenclature

E_1 Late time flow boundary effects constant for Layer 1
E_2 Late time flow boundary effects constant for Layer 2
(i) Axial flow directions x, y, or z
i Distances in x, y, or z directions, ft

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