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Reliability analysis based on model of destructing process

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Abstract: Models of crack growing, deforming, crack propagating, and creeping processes have been made. The models explain about the processes of crack growing, deforming, crack propagating, and creeping and the effects of loads and strengths. All of these parameters can be analyzed by simulation software using Microsoft Excel Program. The models are developed on the basis of five principles i.e. fracture Irwin's theory, fatigue Paris's Law, rupture Larsen-Miller parameters, tension ASME VIII-1 constituent, stress and corrosion ASME B31-1 constituents, and probabilistical pressure and temperature randoming constituent. The deterministic states of Irwin's theory, Paris's Law, ASME VIII-1 constituent, and ASME B31-1 constituent were applied on the mechanical degradation in solid. The probabilistical pressure and temperature randoming was carried out using two principles theories; statistics of pressure and temperature and randoming rules on pressure and temperature. Reliabilities analyses based on models of crack growing, deforming, crack propagating, and creeping processes were modeled deterministically and probabilistically based on the above principles.

Index Terms— reliability, models of crack growing, deforming, crack propagating, and creeping processes, Microsoft Excel Program, fracture Irwin's theory, fatigue Paris's Law, rupture Larsen-Miller parameters, tension ASME VIII-1 constituent, stress and corrosion ASME B31-1 constituent, and probabilistical pressure and temperature randoming constituent.

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1 MODEL OF DESTRUCTING PROCESS

Model of destructing process is way of specifying the individuality of the interaction of load, strength, responding attempt, and time. The model explains about the process of destructing and the effects of load and strength. The model is based on two principles i.e. coupled investigation principle [12] and deterministical process of destructing constituent. The deterministic state of coupled investigation principle [12] is used in the application on the structural – environmental interaction in solid. The deterministical process of destructing is treated with several principles theories; physical phenomenon theories. Relation as follow linked to the system is.

$$r \approx \sigma \tag{1}$$

Where, relation above linked to the system is relation of responding attempt (r) and stress (σ). Relation as follow linked to the system is relation of responding attempt (r) and ratio of load (σ) and strength (σ_0):

$$r \approx \frac{\sigma}{\sigma_0} \tag{2}$$

Where, load is independent variable, strength is independent variable, and responding attempt is dependent variable. The phenomenological relation of state variables in the system at the process is deterministic state. Responding attempt held phenomenological between 0 - ∞ ratio of load and strength.
Effect of load and strength are way of specifying the individuality of the interaction of load and strength. The effects of load and strength as follow describe about the attempts of saving and destructing (r_i) and the effects of ratio of load (σ) and strength (σ_0) when the ratio not yet and yet exceeds 1 of system:

$$r_i = 1, when \frac{\sigma}{\sigma_0} \le 1$$

and

$$r_i = 0, when \frac{\sigma}{\sigma_0} > 1 \tag{3}$$

Where, the effects base their developments on two principles i.e. deterministical ratio of load and strength destructing principle and deterministical process of destructing constituent. The deterministic state of deterministical ratio of load and strength destructing principle is used in the application on the mechanical degradation in solid. The deterministical process of destructing is treated with several principles theories; physical phenomenon theories. The ratio of load and strength is modeled phenomenologically based on the above principles. The ratio of load and strength model is governed by the rules of the ratio of load and strength type, scale, limitation, application and state. General type of ratio of load and strength is ratio of stress and strength. The type of ratio of load and strength has solid bulk scale. General failurance ratio of load and strength is 1. Measurements used in ratio of load and strength are saving and destructing attempts in dimensionless unit. Range of saving attempt is between 0 – 1 and range of destructing attempt is equal to and bigger than 1. Phenomeno-

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logical condition linked to the system is deterministic state. Range of phenomenological condition linked to the system is 0 - ∞ ratio of load and strength.

2 RELIABILITY CALCULATION BASED ON MODEL OF DESTRUCTING PROCESS

Model of reliability of failure event depends on the totality of the ratio of saving attempts and loading attempts. The model states about the degree of belief of saving process and the effects of ratio of saving attempts and loading attempts. The model as follow bases its development on ratio of total saving and loading attempts principle and probabilistical reliability of system modeling constituent.

$$R_j = \sum_{i}^{n} \frac{r_i}{n} \tag{4}$$

Where, the deterministic state of ratio of total saving attempts (r_i) and loading attempts (n) principle is applied on the incremental evaluation of reliability (R_j). The probabilistical reliability of system modeling is carried out using one principle incremental evaluation; series states reliabilitities of failure events (R) as follow:

$$R = \prod_{j}^{n} R_j \tag{5}$$

Where, the reliability of the failure event is modeled mathematically based on the above principles. The reliability of the failure event model is governed by the rules of the probabilistical pressure and temperature randoming constituents. Probabilistical pressure and temperature randoming constituent as follow [2] is:

$$L_m = x_m + (\theta_m - x_m)\left(-\ln\left[1 - rand()_m\right]\right)^{\frac{1}{\beta m}} \tag{6}$$

Where, the function of probabilistical has normal-weibull distribution. General range of loading attempts is 0 – n loading attempts. Statistical parameters and computed random number used in normal-weibull distribution of probabilistical are (x_m, θ_m and β_m) and $rand()_m$ in dimensionles unit. x_m, θ_m and β_m as follow of normal-weibull distribution [2] are between mean and deviation standard value of pressure[8] and temperature[11].

$$x_m = l_m^{Mean} - 3.1394473\left(l_m^{STD}\right) \tag{7}$$

$$\theta_m = l_m^{Mean} + 0.3530184\left(l_m^{STD}\right) \tag{8}$$

$$\beta m = 3.44 \tag{9}$$

3 MEAN TIME TO FAILURE CALCULATION BASED ON MODEL OF DESTRUCTING PROCESS

Mathematic solution of mean time to failure for the individuality of the interaction of load, strength, responding attempt, and time is intended first timed sequence (t_0) plus ratio of 1 and failure rate (λ). The MTFF as follow approximates about the average time of destructing and the effects of ratio of destructing attempts and loading attempts.

$$MTTF = t_0 + \frac{1}{\lambda} \tag{10}$$

Where, the MTTF is according to largest frequent failurance loading attempts and failurance timed sequence gradient principle and sequence summation principle. The determinisitic state of gradient principle is used in the application on the incremental summation. The sequence summation principle is treated with one principle summation; intended first timed sequence plus ratio of 1 and failure rate λ. The MTTF as follow is modeled mathematically based on the above principles.

$$MTTF = n_0 + \frac{\Delta n \cdot n}{\sum n_f} \tag{11}$$

Where, the MTTF model is governed by the rules of the intended first timed sequence n_0, failurance incremental sequence Δn, total failurance loading attempts n_f, and total destructing attempts n.

4 APPLICATION ON A SEAMLESS SWAGED GAS CYLINDER

Several models of destructing processes have been made of models of crack growing, deforming, crack propagating, and creeping processes [1] in the Gas cylinder operation under corrosion atmosphere. The models of crack growing, deforming, crack propagating, and creeping processes tell about the processes of destructing and the effects of loads and strengths. The destructing processes models are governed by the rules of the processes operating condition, construction, dimension, material, and timed sequence at operation. Operating condition is 81.28 ± 3.38 Fahrenheit degree and 2.8 ± 0.2 ksi pressure and temperature applications. The type of construction has solid one – workpiece construction shape.

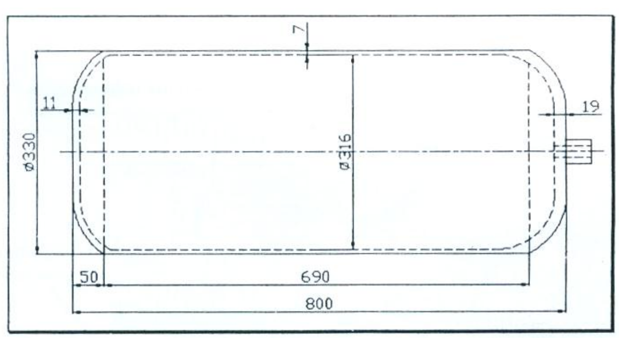

Fig.1.Dimension of Gas Cylinder (in millimeters) [8]

Actual dimension is 12.44 inches inside diameter and 0.28 inches shell thickness. Material used in construction of GC is AISI 4340 steel in 200 ksi yield strength [6], 20 rupture material constant [1], and 10-11 and 3 A and M fatigue strength constant [9]. Range of crack growing, deforming, crack propagating, and creeping processes are between fabricating – destructing processes of GC.

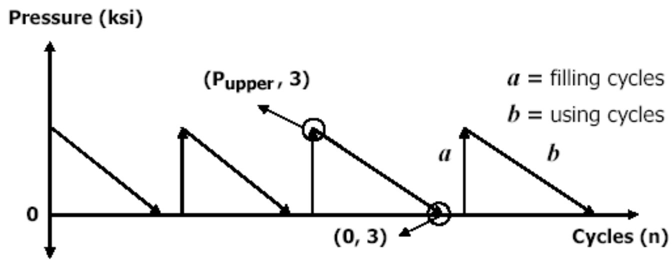

Fig.2.Gas Cylinder filling – using cycles

Incremental sequences linked to the GC are 10 cycles, 1.67 years, 0.01 inches, and 1.67 years. Range of crack growing, deforming, crack propagating, and creeping processes linked to the GC are 0 cycles – 100 cycles, 1.67 years – 16.67 years, 0.1 inches – 0.2 inches, and 1.67 years – 16.67 years. The external corrosions of atmosphere in the GC at the processes are deterministic states. External corrosion rates held constant between 0 mm/year – 0.3 mm/year, 0 mm/year – 0.3 mm/year, 0 mm/year – 0.3 mm/year, and 0 mm/year – 0.45 mm/year.

4.1. Reliability analysis based on model of crack growing process

State variables of load, strength, responding attempt, and time for the individuality of the interaction of workpiece-gas of GC-gas, the ability of workpiece to resist workpiece fast crack growth from depth to depth, and the workpiece crack growth from depth to depth are tangential stress, fatigue strength, and crack growing attempt [12]. The model of crack growing process is harmony to the four principles of phenomenon theories i.e. tension ASME VIII-1 constituent [5], stress and corrosion ASME B31-3 constituents [6], fatigue Paris's Law [10], and probabilistical pressure and temperature randoming constituent [2]. The deterministic states of ASME VIII-1 and ASME B31-1 constituents are applied on the mechanical tension, deformation, corrosion, and degradation in solid. Probabilistical pressure and temperature randoming constituents linked to the GC are statistics of pressure and temperature and randoming rules on pressure and temperature. The reliability of the fatigue event deals with phenomenologically growable crack and phenomenologically degradable shell, and changes to process of crack growing. Monte Carlo simulation verifies the reliability of the fatigue event calculation and confirms the deterministical load and strength and the probabilistical pressure and temperature. Coupled investigation validates the model of crack growing process and confirms the factual observation.

All of cracks can be produced by GC corresponding with crack depth. General measurement of crack depth is crack depth level. Unit used in measurement of crack depth level is inches or mm in SI. Level of saving attempt is between initial crack depth level – critical crack depth level. Saving attempt linked to the GC is slow crack growing attempt and destructing attempt linked to the GC is fast crack growing attempt. The physical condition of fast crack growing attempt in the GC at the process is deterministic state.

Relation as follow [5], [1] linked to the GC is relation of saving and fast crack growing attempts (r_i) when ratio of tangential stress and fatigue strength not yet and yet exceeds 1 of GC:

Saving attempt if $r_i = 1$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2\cdot t}+0.6\right]}{\sqrt[m]{\frac{1}{A\cdot\pi^2\cdot N}\cdot\left\{\frac{1}{a_0}-\frac{1}{\left(\frac{K_{IC}}{Y\cdot S_{X\,max}}\right)^2\cdot\frac{1}{\pi}}\right\}}}<1$$

and, fast crack growing attempt if $r_i = 0$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2\cdot t}+0.6\right]}{\sqrt[m]{\frac{1}{A\cdot\pi^2\cdot N}\cdot\left\{\frac{1}{a_0}-\frac{1}{\left(\frac{K_{IC}}{Y\cdot S_{X\,max}}\right)^2\cdot\frac{1}{\pi}}\right\}}}\geq 1 \quad (12)$$

Where, limitation used in ratio of tangential stress and fatigue strength is 1 in dimensionless unit. P, E, d, t, m – A, N, a_0, K_{ic}, Y, and S_{xmax} linked to the GC are pressure, weld joint factor, inner diameter, shell thickness, material constants, cycles, first initial crack depth, stress intensity factor, crack geometry correction factor, and maximum tangential stress. The phenomenological conditions of K_{ic}, S_0, Y, and d as follow [3], [6], [10], [6] in the GC at the process are deterministic states.

$$K_{IC} = 273.348 - 0.914\cdot S_0 \quad (13)$$

$$S_0 = \sigma_0 - 0.04\cdot T \quad (14)$$

$$Y = 6.7857\cdot\left(\frac{a}{t}\right)^2 + 0.1786\cdot\frac{a}{t} + 1.05 \quad (15)$$

$$d_i = d_0 - 2A_E - c\cdot T \quad (16)$$

Where, K_{ic} , S_0, σ_0 , Y, a, t, T, d_i , d_0, A_E , c, and T linked to the GC are stress intensity factor, yied strength, 0F yield stress, crack geometry correction factor, actual crack depth, shell thickness, temperature, inner diameter, design or actual iner diameter, internal allowance for design thickness, internal thinning rate, and operation time.

Incremental ratio of total saving attempts (r_i) and loading attempts (n) is reliability of fatigue event (R_1).

$$R_1 = \sum_i^n \frac{r_i}{n} \quad (17)$$

Interval probability as follow is 0 cycles – 100 cycles interval probability:

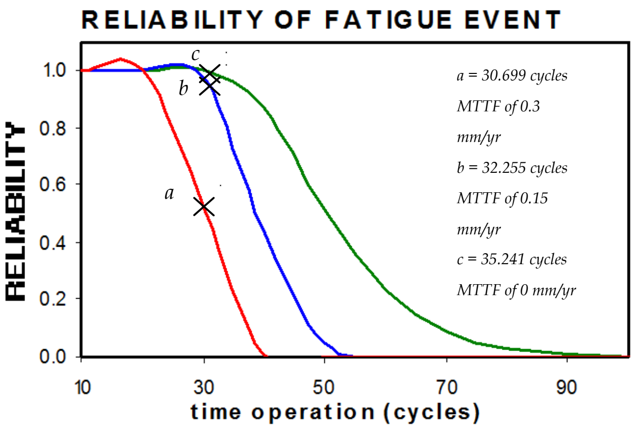

Fig.3.Reliability of fatigue event

Where, reliability of fatigue event (R_1) explains about the degree of belief of saving process and the effects of ratio of saving attempts and loading attempts and the mean time to fatigue event (MTTF) is developed on the basis of largest frequent failurance loading attempts and failurance timed sequence gradient principle and sequence summation principle.

4.2. Reliability analysis based on model of deforming process

Tangential stress, yield strength, and deforming attempt stages are measurements of load, strength, and responding attempt for the individuality of the interaction of workpiece-gas of GC-gas, the ability of workpiece to resist workpiece plastic deformation from breadth to breadth, and the workpiece deformation from breadth to breadth [12]. The model of deforming process founds its development on three principles i.e. tension ASME VIII-1 constituent [5], stress and corrosion ASME B31-1 constituents [6], and probabilistical pressure and temperature randoming constituent [2]. The deterministic states of ASME VIII-1 and ASME B31-3 constituents are applied on the mechanical tension, stress, corrosion, and degradation in solid. The probabilistical pressure and temperature randoming is carried out using two principle theories; statistics of pressure and temperature and randoming rules on pressure and temperature. The deforming process is modeled mathematically based on the above principles. Reliability linked to the GC is reliability of yield event. Monte Carlo simulation verifies the reliability of the yield event calculation and confirms the deterministical load and strength and the probabilistical pressure and temperature. Coupled investigation validates the model of deforming process and confirms the factual observation.

Model of GC elastoforming and plastoforming processes is way of specifying the individuality of the workpiece elastic and plastic deformations from breadth to breadth [12]. The model explains about the processes of GC elastoforming and plastoforming and the effect of microstructural. The GC elastoforming and plastoforming processes are modeled temporary and permanently based on the workpiece elastic and plastic deformations from breadth to breadth. The GC elastoforming and plastoforming processes models are governed by the rules of the two modes as elastic mode and plastic mode. Saving attempt linked to the GC is elastic deforming attempt and destructing attempt linked to the GC is plastic deforming attempt. Plastic deformation occurrence is often phenomenologically based on permanently workpiece deformation from breadth to breadth and dimension change as long as the workpiece and the dimension are a changeable workpiece and a changeable dimension.

Relation as follow [5], [6] linked to the GC is relation of saving and yielding attempts (r_i) when ratio of tangential stress and yield strength not yet and yet exceeds 1 of GC:

Saving attempt if $r_i = 1$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2 \cdot t} + 0.6\right]}{S_0} < 1$$

and, yielding attempt if $r_i = 1$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2 \quad t} + 0.6\right]}{S_0} \geq 1 \quad (18)$$

Where, limitation used in ratio of tangential stress and yield strength is 1 in dimensionless unit. P, E, d, t, and S_0 linked to the GC are pressure, weld joint factor, inner diameter, shell thickness, and yield strength. The physical condition of inner diameter d in the GC at the process is deterministic state.

Incremental ratio of total saving attempts (r_i) and loading attempts (n) is reliability of yield event (R_2).

$$R_2 = \sum_i^n \frac{r_i}{n} \quad (19)$$

The physical conditions of interval probability as follow has solid 1.67 years – 16.67 years shape:

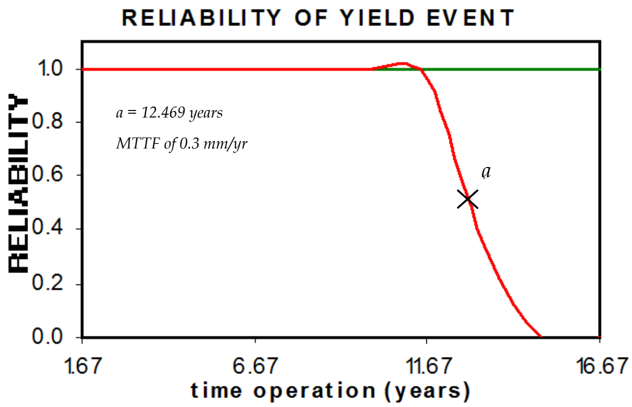

Fig.4.Reliability of yield event

Where, reliability of yield event (R_2) of saving process degree depends on the totality of the ratio of saving attempts (r_i) and loading attempts (n) and the determinisitic state of largest frequent failurance loading attempts and failurance timed sequence gradient principle is applied on the incremental summation.

4.3. Reliability analysis based on model of crack propagating process

Measurements of load, strength, and responding attempt are tangential stress, fracture strength, and crack propagating attempt stages of state variables for the individuality of the interaction of workpiece-gas of GC-gas, the ability of workpiece to resist workpiece fast crack propagation from depth to depth, and the workpiece crack propagation from depth to depth [12]. The model of crack propagating process bases its development on four principles i.e. tension ASME VIII-1 [5], stress and corrosion ASME B31-1 constituents [6], fracture Irwin's theory [3], and probabilistical pressure and temperature randoming constituent [2]. General principles of the model are ASME VIII-1 constituent, ASME B31-1 constituent, and Irwin's theory. Probabilistical pressure and temperature randoming constituents linked to the GC are statistics of pressure and temperature and randoming rules on pressure and temperature. Monte Carlo simulation verifies the reliability of the fracture event calculation and confirms the deterministical load and strength and the probabilistical pressure and temperature. Coupled investigation validates the model of crack propagating process and confirms the factual observation.

Relation as follow [5], [3] linked to the GC is relation of saving and fast crack propagating attempts (r_i) when ratio of tangential stress and fracture strength not yet and yet exceeds 1 of GC:

Saving attempt if $r_i = 1$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2\cdot t}+0.6\right]}{\frac{K_{IC}}{Y\cdot\sqrt{\pi\cdot a}}}<1$$

and, fast crack propagating attempt if $r_i = 0$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2\cdot t}+0.6\right]}{\frac{K_{IC}}{Y\cdot\sqrt{\pi\cdot a}}}\geq 1 \qquad (20)$$

Where, limitation used in ratio of tangential stress and fracture strength is 1 in dimensionless unit. P, E, d, t, K_{ic}, Y, and a linked to the GC are pressure, weld joint factor, inner diameter, shell thickness, stress intensity factor, crack geometry correction factor, and actual crack depth. The physical conditions of stress intensity factor K_{ic}, crack geometry correction factor Y, and inner diameter d in the GC at the process are deterministic states.

Incremental ratio of total saving attempts (r_i) and loading attempts (n) is reliability of fracture event (R_3).

$$R_3 = \sum_{i}^{n}\frac{r_i}{n} \qquad (21)$$

Total timed sequence of interval probability is 0.1 inches – 0.2 inches:

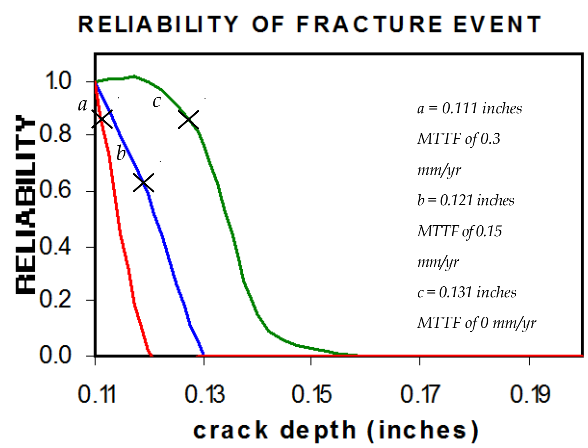

Fig.5.Reliability of fracture event

Where, the sequence summation principle is carried out using one principle summation; intended first timed sequence plus ratio of 1 and failure rate λ and reliability linked to the GC is reliability of fracture event (R_3).

4.4. Reliability analysis based on model of creeping process

A set phenomenological tangential stress, microstructural strength, and microstructural propagation solutions for the individuality of the interaction of workpiece-gas of GC-gas, the ability of workpiece to resist workpiece rupture strain from breadth to breadth, and the workpiece strain from breadth to breadth determine the tangential stress, rupture strength, and creeping attempt stages [12]. The model of creeping process is based on four principles i.e. tension ASME VIII-1 constituent [5], corrosion ASME B31-3 constituent [6], rupture Larsen-Miller parameter [1], and probabilistical temperature and pressure randoming constituent [2]. The deterministic states of ASME VIII-1 constituent, ASME B31-3 constituent, and Larsen-Miller parameter are applied on the mechanical tension, stress, corrosion, and the microstructural degradation in solid. The probabilistical pressure and temperature randoming is carried out using two principles theories; statistics of pressure and temperature and randoming rules on pressure and temperature. The creeping process is modeled mathematically based on the above principles.

All of microdefects can be produced by GC corresponding with actual creep strain. General measurement of actual creep strain is a creep strain level. Unit used in measurement of creep strain level is percent in inches/inches or mm/mm. Level of saving attempt is between primary, secondary, and final creep strain level – rupture level [1]. Saving attempt linked to the GC is creeping attempt and destructing attempt linked to the GC is rupturing attempt. The physical condition of rupturing attempt in the critical creep strain level at the process is deterministic state.

General relation of state variables [6], [1] is relation of saving and rupturing attempts (r_i) when ratio of tangential stress and rupture strength not yet and yet exceeds 1 of GC:

Saving attempt if $r_i = 1$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2\cdot t}+0.6\right]}{m\left(P_{LM}-P_{\max}\right)}<1$$

and, rupturing attempt if $r_i = 0$, when

$$\frac{\frac{P}{E}\left[\frac{d}{2\cdot t}+0.6\right]}{m\left(P_{LM}-P_{\max}\right)}<1 \qquad (22)$$

Where, limitation used in ratio of tangential stress and rupture strength is 1 in dimensionless unit. P, E, d, t, m, P_{LM}, P_{max} linked to the GC are pressure, weld joint factor, inner diameter, shell thickness, Larsen-Miller diagram gradient, Larsen-Miller parameter, and Larsen Miller parameter maximum. The physical condition of P_{LM} [1] in the GC at the process is deterministic state.

$$P_{LM} = T\left(\log t_r + C_l\right) \qquad (23)$$

Where, P_{LM}, T, t_r, and C_l linked to the GC are Larsen-Miller parameter, temperature, rupture time, and material constant.

Ratio of total saving attempts (r_i) and loading attempts (n) is reliability of rupture event (R_4).

$$R_4 = \sum_i^n \frac{r_i}{n} \qquad (24)$$

Timed sequence used in interval probability of analysis is breadth strain level in 1.67 years – 16.67 years:

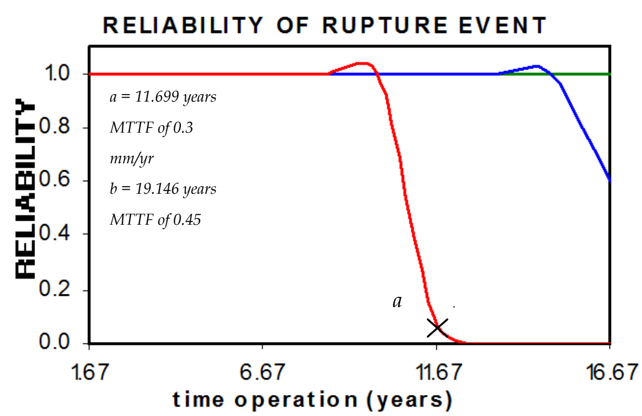

Fig.6.Reliability of rupture event

Where, the MTTF is modeled mathematically based on the largest frequent failurance loading attempts and failurance timed sequence gradient principle and sequence summation principle and Monte Carlo simulation verifies the reliability of the rupture event (R_4) calculation and confirms the deterministical tangential stress and rupture strength and the probabilistical pressure and temperature.

4.5. Reliability analysis based on models of crack growing and creeping processes

Applications of tangential stress, fatigue and rupture strengths, and crack growing and creeping attempts stages focus on the totality of the interaction of workpiece-gas of GC-gas, the abilities of workpiece to resist workpiece fast crack growth and rupture strain from depth to depth and breadth to breadth, and the workpiece crack growth and strain from depth to depth and breadth to breadth [12]. The models of crack growing and creeping processes are according to four principles i.e. tension ASME VIII-1 constituent [5], stress and corrosion ASME B31-1 constituent [6], rupture Larsen-Miller parameter [1], fatigue Paris's Law [10] and probabilistical pressure and temperature randoming constituent [5]. The deterministic states of ASME VIII-1 constituent, ASME B31-1 constituent, Larsen-Miller parameter are ap-

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plied on the mechanical tension, stress, corrosion, and degradation in solid. The probabilistical pressure and temperature randoming is carried out using two principles theories; statistics of pressure and temperature and randoming rules on pressure and temperature. The crack growing and creeping processes are modeled mathematically based on the above principles. The physical condition of series states reliabilities of rupture and fatigue events ($R_{4,1}$) as follow in the GC at the processes is deterministic state.

$$R_{4,1} = \prod R_{4,1} = R_4 \cdot R_1 \qquad (25)$$

Timed sequence of interval probability is between 1.67 years – 16.67 years:

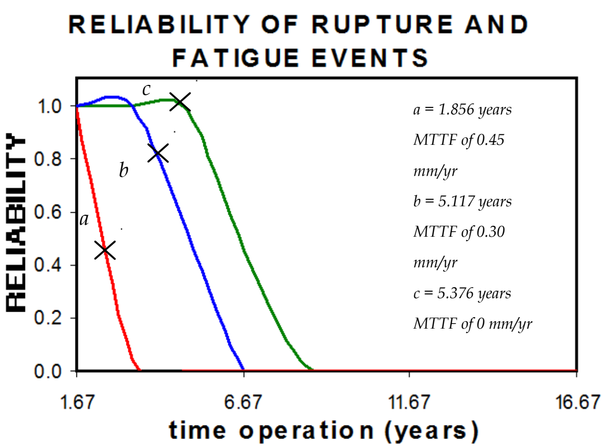

Fig.7.Reliabilities of rupture and fatigue events

Where, reliability ($R_{4,1}$) above is series states reliabilities of rupture and fatigue events ($R_{4,1}$) and reliability of rupture event multiplying reliability of fatigue event are reliabilities of rupture and fatigue events ($R_{4,1}$).

4.6. Reliability analysis based on models of crack propagating and deforming processes

Load, strengths, and responding attempts are solved by replacing the totality of the interaction of workpiece-gas of GC-gas, the abilities of workpiece to resist workpiece fast crack propagation and plastic deformation from depth to depth and breadth to breadth, and the crack propagation and deformation from depth to depth and breadth to breadth functions with tangential stress, yield and fracture strengths, and deforming and crack propagating attempts stages approximations [12]. The models of crack propagating and deforming processes are harmony to four principles of phenomenon theories i.e. tension ASME VIII-1 constituent [5], stress and corrosion ASME B31-1 constituents [6], fracture Irwin's theory [3] and probabilistical pressure and temperature randoming constituent [2]. The deterministic states of ASME VIII-1 constituent, ASME B31-1 constituent, Irwin's theory are applied on the mechanical tension, stress, corrosion, and degradation in solid. The probabilistical pressure and temperature randoming is carried out using two principles theories; statistics of pressure and temperature and randoming rules on pressure and temperature. The crack propagating and deforming processes are modeled mathematically based on the above principles. The deforming and crack propagating processes models are governed by the rules of the states variables types, scales, measurements, specifications, limitations, and principles at timed sequences as mentioned in the 4.2. and 4.3 sections. The physical condition of series states reliabilities of fracture and yield events ($R_{2,3}$) as follow in the GC at the processes is deterministic state.

$$R_{2,3} = \prod R_{2,3} = R_2 \cdot R_3 \qquad (26)$$

Timed sequence of interval probability linked to the analysis is 1.67 years – 16.67 years:

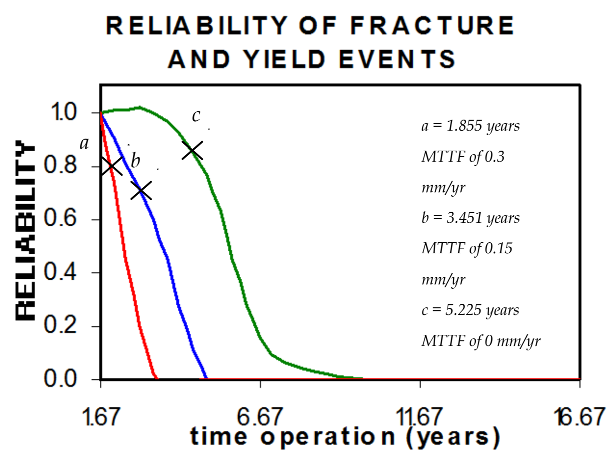

Fig.8.Reliabilities of fracture and yield events

Where, the series states reliabilities of the fracture and yield events ($R_{2,3}$) have solid degrees of belief of saving processes shape and reliability of fracture event multiplying reliability of yield event are reliabilities of fracture and yield events ($R_{2,3}$).

4 CONCLUSION

Model of destructing process not only rules in process or phenomenon analysis but simplifies reliability calculation approach in which this analysis uses new mathematical approach combined with traditional Monte Carlo method.

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SYMBOLS AND ABBREVIATIONS (UNITS)

a_0	first initial crack depth (inches)
β_m	beta statistical parameter (dimensionless unit)
Cl	rupture material constant
d	inner diameter (inches)
Δn	failurance incremental sequence (cycles, inches, or years)
E	weld joint factor (dimensionless unit)
GC	Gas Cylinder
K_{ic}	stress intensity factor (dimensionless unit)
λ	failure rate (cycles-1, inches-1, or years-1)
M	Larsen-Miller diagram gradient (ksi. 10 3 years)
MTTF	Mean Time to Failure Event (cycles, inches, or years)
m – A	fatigue material constants (dimensionless unit)
N	cycles (cycles)
n	loading attempts (dimensionless unit)
n_d	total destructing attempts (dimensionless unit)
nf	total failurance loading attempts (dimensionless unit)
n_0	intended first timed sequence (cycles, inches, or years)
P_{LM}	Larsen-Miller parameter
P_{max}	Larsen Miller parameter maximum
P	pressure (ksi)
R	reliability of failure event (dimensionless unit)
R_j	series state reliability of failure events (dimensionless unit)
r	responding attempt (arbitrary units)
$rand()_m$	computed random number (dimensionless unit)
r_i	saving and destructing attempts (dimensionless unit)
SI	Standard International
S_{xmax}	maximum tangential stress (ksi)
S_0	yield strength (ksi)
σ_0	strength (ksi)
σ	stress (ksi)
T	temperature (F)
t	shell thickness (inches)
t_0	intended first timed sequence (cycles, inches, or years)
t_r	rupture time (10 3 years)
θ_m	theta statistical parameter (dimensionless unit)
x_m	chi statistical parameter (dimensionless unit)
Y	crack geometry correction factor (dimensionless unit)